Case Study of a Patient with the Diagnosis of Disease of Lumbo-Sacral Intervertebral Discs with L5 Sensory-motoric Deficit

by

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Abstract

Abstract Title: Case study of a patient with the diagnosis of disease of lumbosacral intervertebral discs with L5 sensory-motoric deficit.

Details: This bachelor's thesis focuses on the problems found in degenerative disc disease, particularly in the case of L4-L5 disc prolapse with additional L5 radiculopathy irritation syndrome and light sensory-motoric deficit in the right lower extremity.

Aims of the Thesis: The aims of this thesis are to research the disease, its etiology and the profound effects it may have on the individual, as well as to explore the different physiotherapeutic methods of treatment and their overall impact on the patient's condition.

Methodology: The thesis is structured into two main parts: theoretical and practical. The theoretical section includes the general anatomy and function of the spine; the neuroanatomy and its distribution of sensation, pain, and motor functions; the pathology and etiology of the disease including the common symptomology and movement dysfunctions that arise in degeneration of the discs; and the proposed and current treatment approaches relative to the disease. The practical section comprises a case study based on a patient who suffers from the symptoms of the disease and gave his full voluntary consent to participate in this study. This part describes an interview with the patient, a full initial kinesiological examination and its results, short and long-term treatment plans tailored accordingly to his condition, the progress of the therapy, a final kinesiological examination, and the final results of the therapy.

- ***Duration of Therapy:*** There were five sessions with the patient in total. Two days were weekend days during which the patient followed a self-therapy plan.

- ***Implemented Therapy:*** McKenzie exercises of the spine (with the use of overpressure) ; Breathing exercises with activation of the "core" muscles; PIR techniques according to Lewit; Sensory-motoric stabilization training according to Janda; Soft tissue techniques according to Lewit; Joint mobilization by Lewit; Re-education of basic movement patterns; and teaching the proper ergonomics and posture in ADL.

Result: The therapy outcome had positive results. The patient achieved overall improvement in ROM of the lower extremities; he also achieved improved ROM of the skin, fascia, and mobility in the lumbar spine; the breathing pattern was normalized by activation of the core muscle chain; Joint mobility was improved; the pain became "centralized" in the lumbar spine – this means it moved away from the affected extremity toward the site of origin in the spine. Another profound result was the re-appearance of deep tendon reflexes in the right lower extremity.

Key Words: Case study, rehabilitation of a patient, lumbosacral disc disease, L4-L5 disc prolapse, radiculopathy irritation syndrome, L5 sensory-motoric deficit

Declaration

I hereby declare, that this work entirely my own individual work, based on knowledge gained from books, journals, casuistic reports, website articles, lectures, courses and clinical practices attended at the Faculty of Physical Education and Sport, UVN, Monada, Rheumatologicky Ustav, CLPA and other health care centers (both in Prague and the U.S.)

I also declare, that no invasive methods were used during this case study by any physical means, and the patient was fully informed of the procedures in which he was involved.

Prague, April 2013

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Acknowledgements

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Thank you. It has been a life-changing experience.

Danielle Frank,

Prague, April 2013.

1 Introduction

Objectives: The objectives of this thesis are to administer various methods of physical therapy as a treatment and prevention to a patient with the diagnosis of disease of the lumbosacral joints with L5 sensory-motoric deficit, as well as to collect data and objectify the outcomes of the therapy. The collection of data can be found in the supplements of this thesis.

This case study was conducted at Ústrední Vojenské Nemocnice (Military University Hospital) in the Department of Neurology (Pavilion A), in Prague. The duration of the clinical practice was two weeks in total.

2 Investigation

2.1 Anatomy and Kinesiology of the Spine

Structure and Function of the Spine

The spine is a mechanical structure that functions as a base support for the upright posture of the human body. Also functioning as a protector mechanism, it encases the delicate spinal cord and its nerve roots from outside damaging forces. It creates a base for the ribcage and supports the head. It is anchored to the pelvis creating a kinetic chain with the legs and feet at one end – and the head, jaw, neck, upper back, shoulders and arms at the other end. (Vickery & Moffat, 2011) Biomechanically, it acts as a shock absorber during gait and disperses the compressive forces that the body constantly endures during day-to-day activities.

Extending the length from the head to the pelvis, the spine is composed of 24 mobile bony intersecting vertebral bodies and their interlocking cartilaginous discs and approximately 9 fused vertebral bodies. It is categorized into five different sections: the cervical spine (C1-7), thoracic spine (Th1-12), lumbar spine (L1-5), sacrum (S1-5) and the coccyx. (Drake & Vogl, 2004) The cervical spine is special because where it connects to the head the vertebrae there create the occipital-atlantal-axial complex (C0-C1-C2) a highly mobile area in which there are no intervertebral discs.(Shankar, 2009) The sacrum is located at the end of the spine where the pelvis attaches itself. The sacrum is a single triangular bone that is a developmental fusion of five vertebral bodies. The coccyx or “tail bone” is a fusion of three-to-five small vertebrae projecting off the bottom of the sacral bone. (Vickery & Moffat, 2011)

A healthy spine forms natural curves that give slight buoyancy and flexibility during gait and movement. *The normal curves of the spine consist of a curve that is convex forward in the neck (cervical region), a curve that is convex backward in the upper back (thoracic region), and a curve that is convex forward in the low back (lumbar region).* (Kendall, 2005) Maintaining these natural curves is essential to good posture and movement. These curves should neither be exaggerated nor inhibited, and should be able to maintain the pelvis in a neutral position.

Between each vertebral body is an intervertebral disc. The disc gives the spine its absorbency and cushion in conjunction with the natural curves of the spine. The disc also helps to maintain proper spatial orientation for the vertebral bodies and facet joints. Each disc is approximately 8-10mm in height and 4cm in diameter. (Shankar, 2004) The thickness and surface area of the disc is the thinnest at the cervical spine level and the greatest at the lumbar spine level – the part of the spine that takes the most "punishment" due to mechanical loading. (Shankar, 2004) An intervertebral disc is dependent on its nutrition through diffusion/osmosis since there is no vascular supply to the disc. Diffusion is only possible through movement of the spine, and consequently inactivity is the biggest cause of most all spine diseases. (Rajasekaran, 2004) In other words, movement helps keep the discs healthy. We can imagine an intervertebral disc to be like a jelly-filled donut – containing a peripheral part called the *annulus fibrosis*, which is made up of layers of thick fibrocartilage with sensory nerve endings; and a center with a soft jelly-like substance called the *nucleus pulposus*. (Netter, 2010) The pulposus is deformable, composed mainly from water (70-90%) with the rest being protein and collagen. (Shankar, 2004) The disc is protected at the top and bottom by endplates that connect it to each of the adjacent bony vertebra.

Each vertebral body is shaped in such a way that it interlocks with the adjacent one by two zygopophyseal joints or "facet joints" fixated by ligaments. These joints allow a reasonable amount of movement while at the same time the ligaments prevent extreme hyperextended or hyperflexed movements (ie. whiplash). The facet joints are located on the posterior side of the vertebra between the articular processes of the pedicle and next to the anterior and posterior longitudinal ligaments. Small notches, called foramina, are located in the articular processes that allow for the entry of nerve roots from the spinal cord to pass through on either side of the pedicles. (Netter, 2010) When the spine is looked upon as a whole, these areas are called the intervertebral foramen; not to be confused with the vertebral foramen, or "spinal canal" which is located posterior to the vertebral body. (Drake & Vogl, 2004)

Movement of the Spine

The natural movements of the spine are flexion, extension, latero-flexion (side bending), and axial rotation (twisting) but each section of the spine has its own variable degree of range of motion. (Vickery & Moffat, 2011) The cervical spine, which mainly supports the head (approx. 10 lbs. or 4 kg. of weight), has the greatest range of motion, with the most mobile part being the C0-C1-C2 complex – 60% of rotation of the cervical spine occurs here! The thoracic spine is more limited in range because it must provide stability for the rib cage – this added weight increases the required load necessary to cause buckling of the spine. (Rawls & Fisher, 2010) Rotation occurs mainly in the cervical and thoracic regions. Little or no rotation occurs in the lower back, as this motion is blocked by the position and orientation of the facet joints – the location of facets on the lumbar spine vertebrae facilitates flexion and extension more than rotation. The normal degrees of range of motion of the lumbar spine are 15 degrees of extension, 40 degrees of flexion, 30 degrees of lateral flexion, and 40 degrees of lateral rotation. The sacrum is mobile in such a way that it is able to nutate (rotate forward and down) and counternutate (rotate up and back) as a single fused bone. (Vickery & Moffat, 2011)

Movement of the Vertebrae

The vertebrae move fluently together with each movement of the spine – one segment before the next. In flexion, the vertebrae separate or distance themselves from one another; whereas in extension, the vertebral segments "approximate" or move closer together. In latero-flexion, the transverse processes of segments on the moving side approximate, and separate on the opposite side. In rotation, each segment moves with the direction of rotation, such that the opposing transverse process leads in the direction of the movement.

Certain segments of the spine move with more dominance in relation to other segments. C0-C1 and C1-C2 are the most mobile segments of the cervical spine. (Shankar, 2004) The atlanto-occipital (C0-C1) joint is also known as the "yes" joint, as the movement of the vertebrae on the occiput corresponds to nodding, or flexion and extension of the head, primarily. On the other hand, the atlanto-axial joint (C1-C2) is called the "no" joint as the primary movement of this segment of the cervical spine is “shaking the head in disapproval” as rotation is the most prominent movement in this segment. Thoracic segments are more restricted than cervical but still provide a large range of movement. The lumbar segments are the least mobile since they must work to stabilize, rather than to move.

Spinal Ligaments

The ligaments of the spinal column are of great importance to the stability of both the individual vertebral segment and the spine as a whole. The ligaments function with the muscles to provide joint stability during rest and movement, and to prevent extreme hyperextended and injurious movements to the spine. (Panjabi, 2006) A ligament is composed of tough, fibrous connective tissue (collagen) and connects bones to bones to create a joint. (Vickery & Moffat, 2011) The *anterior longitudinal ligament* is a primary spine stabilizer that runs the entire length of the spine from the base of the skull to the sacrum. It connects the anterior of the vertebral body to the anterior of the annulus fibrosus. The *posterior longitudinal ligament*, also a primary spine stabilizer, runs the entire length of the spine, connecting the posterior of the vertebral body to the posterior annulus fibrosus. The *supraspinous ligament* attaches to the tip of each spinous process to the next. The *interspinous ligament* is a thin ligament that attaches to the great ligamentum flavum giving it extra support. The *ligamentum flavum* is the strongest of all spinal ligaments, running from the base of the skull to the pelvis, and between the lamina to protect the spinal cord and nerves. It also supports the front of the facet joint capsules. (Drake & Vogl, 2004)

Postural Musculature

Muscles which primarily support the spine on the posterior side are the tonic or “postural” muscles and provide movement into extension. Flexors of the spine are located on the anterior side and serve to bend forward. There are many planes of overlapping muscles to provide stability in all directions of movement. (Drake & Vogl, 2004) Strong muscles in combination with good quality of learned movement patterns serve a dominant role in maintaining the spine in an upright position, keeping the natural curves of the spine, protecting the spine from overstrain and harmful movements, eliminating pain and injury to the spine, stabilizing the spine and controlling movements during activity and inactivity. (Hsu & Armon, 2011; Vickery & Moffat, 2011)

Spinal (extensor) muscles that lie behind the spine extend its whole length. Each layer has subdivisions in the neck, midback and lower back. In the deepest layer, the *transversospinalis* muscle group comprises the *multifidus* (in the low back), *semispinalis* (in the midback) and *semispinalis capitis* and *cervicis* (in the neck) and span one or more vertebra supporting individual segments. More superficially, the *erector spinae*, are a group of muscles that run the same direction having multiple tendinous origin attaching to the iliac crest and most of the lumbar and thoracic vertebrae. This group of muscles that appears to be as one muscle is divided into sections of fibers named: *illiocostalis*, *longissimus* and *spinalis*. The erector spinae secondarily contribute to lateral flexion, rotation and movement of the head. Other major trunk muscles, *quadratus lumborum* (which also contributes to lateroflexion of the lumbar spine), *trapezius* and *latissimus dorsi* participate in extending the vertebral column. (Drake & Vogl, 2004; Netter, 2010)

Spinal (flexor) muscles that lie directly in front of the spine are only localized in the cervical and lumbar regions – there are no flexors along the spine in the thoracic region. The *psoas* flexes the trunk at the hip, mainly the pelvis, but has little effect on flexing the spine itself. The main lumbar spine flexors are the abdominals, which lie anterior to the abdomen; these include: the *rectus abdominis*, *transversus abdominis*, *internal* and *external obliques* (which also contribute to rotation). (Netter, 2010)

Muscles that surround the pelvis have a large impact on supporting the spine by stabilizing the pelvis; as pelvic stability and low back stability are closely connected to one another. (Hsu & Armon, 2011) Atrophy or weakening of the gluteal muscle group is attributed to low back pain and can be associated with something as simple as sitting for long periods. (Rawls & Fisher, 2010) Located in the buttock and pelvic region, the *gluteus maximus*, *gluteus medius*, *gluteus minimus* and the *tensor fascia latae* make up the group of gluteal muscles. The pelvic floor muscles have recently been attributed to stability of the pelvis as well. Connections between chronic sacro-illiac restriction and instability as well as breathing pattern dysfunction have been noted. (Leibenson, 2006)

Muscle Imbalance Patterns

Muscle Imbalance Patterns – according to "The Janda Approach" – is a specialized concept in physiotherapy theorized by Czech neurologist and Professor, Dr. Vladimir Janda. He concluded that muscle imbalance patterns originate from the CNS and that tightness and spasticity play a predominant role; the muscle weakness creating the imbalance comes from *"reciprocal inhibition"* (Sherrington) of the tight or spastic antagonist. He found that this all-too-common pattern of muscle imbalance leads to postural disturbance and overloading of joints which consequently forms the dysfunction and degeneration of the joints. The patterns are a result the opposing *postural* (tonic) and *phasic* (weak) muscles. Janda acknowledged three types of patterns that form a stereotypical pattern involving dorsal and ventral muscles in a crossed pattern: *upper crossed syndrome*, *lower crossed syndrome* and *stratification syndrome*. (Janda, 1993)

Fascia and Soft Tissues

According to Prof. Janda – fascia, a living tissue, plays an active role in low back pain, and thus should be considered as influencing muscle and movement. (Janda, 1993) Fasciae are dense connective tissue made up of collagen that surrounds muscles, muscle groups, blood vessels and nerves. There are three layers: superficial fascia, deep (muscle) fascia, and visceral fascia. Fascia binds structures together, while permitting others to slide smoothly over one another. Its collagenous fibers are structured in a wavy pattern so that they run parallel to the direction of pull. Fasciae are flexible and resistant to tension in the direction of their fibers. When they are stretched, the wavy pattern straightens out by the pulling force. (Hsu & Armon, 2011)

Trigger points (TrPs) can easily develop within fascia and muscle in case of a pathological mechanism. Trigger points can be described as hyperirritable points that are usually associated with palpable nodules within taut muscle and fascia – it is possible to find trigger points in over stretched muscle as well. Compression of a trigger point results in referred pain to local or distant area. An area of referred pain is called a hyper algesic zone (HAZ). TrPs can be located in myofascia, cutaneous, fascia, ligaments and periosteal points. Myofascial TrPs give rise to characteristic referred pain, tenderness, and autonomic phenomena or HAZ. Types of myofascial TrPs include active, latent, primary, associated, satellite and secondary. TrPs decrease the muscular stimulation threshold, leading to overuse, early fatigue and weakness. (Travell and Simons, 1999) Muscles with TrPs exhibit a decreased number of firing motor units and poor synchronization. (Janda, 1993)

2.2 Neuroanatomy of the Spine

The Spinal Cord

Toward the posterior side of the stacked vertebral bodies forms the spinal canal, where the spinal cord lies. The outside of the spinal cord is protected by three layers of meningeal membranes that also surround the brain: the *dura mater* (outermost layer), *pia mater*, and *arachnoid mater*. (Netter, 2010) The spinal cord is a highly sensitive structure filled with an abundance of nerve tracts and support cells. It functions as a communicator of the CNS, transmitting neural synapses between the brain and the rest of the body – by conducting motor signals away from the brain and sensory signals towards the brain. But it can also function independently because it contains neural circuits that control and coordinate reflexes and central pattern generators (CPG's) – because of this, it is able to control certain mechanisms such as that of *the gate-pain theory*. (Hsu & Armon, 2011) It connects to the brain at the medulla oblongata, exiting the skull through the foramen magnum, and extending the length of the L1-L2 vertebrae – *not* the full length of the spinal column. Below the termination of the cord the nerve roots form the *cauda equina*. This bundle of nerves and nerve roots stems from the *conus medularis* (end part) of the spinal cord and contains the nerve root pairs of L2-L5, S1-S5 and the coccygeal nerve. (Drake & Vogl, 2004) The nerve roots L4-S4 form the sacral plexus which travels caudally towards the feet. Only within the cervical spine do segmental levels of the cord correspond to bony landmarks (vertebrae); below this level there is increasing inconsistency between levels – such that spinal pathology below L1-L2 presents only with root signs.

At each vertebral segment, nerve roots exit the right and left lateral sulci. Sensory nerves branch out of the dorsal side (through the dorsal lateral sulci) and motor nerves branch out of the ventral side (through the ventral lateral sulci). On the dorsal side, just before exiting each segment of the spinal canal are *dorsal root ganglia* that contain cell bodies of sensory neurons, which transmit information from the periphery to the CNS. On the ventral side, nerve roots consist of motor nerve axons which bring information out to the periphery from the CNS. Both these types of nerve root axons combine and form spinal nerves as they exit the intervertebral foramen on either side of the vertebral column. (Drake & Vogl, 2004)

Gray and White Matter

Inside the spinal cord is gray and white matter. On a cross-sectional view of the spinal cord, the gray matter is shaped like a butterfly and contains cell bodies of interneurons and motor neurons as well as capillaries. Gray matter also consists of neuroglia cells and unmyelinated axons. Neuroglia (or Glia) cells function as support for neurons, surrounding them and internally regulating the environment of the neuron, especially by supplying nutrition, regulating the fluid, and synapses of the neuron. The white matter consists of myelinated axons both motor and sensory. (Drake & Vogl, 2004) Motor (efferent) pathways contain the Pyramidal and Extrapyramidal tracts. Sensory (afferent) pathways include the Lemniscus system, Spinocerebellar tracts, and Antero-lateral system. (Netter, 2010)

Myelination

Nerve fibers may either be myelinated or un-myelinated. In the CNS the myelin is produced from oligodendroglia cells. In the PNS it is produced from Schwann cells. (Netter, 2010) Myelination is the formation of the myelin sheath around the axon of a neuron. Its purpose is to conduct speed between synapses by electrically insulating the neuron. Myelin is a white material, hence “white matter”. Impulses of un-myelinated fibers move continuously as waves, but in myelinated fibers the impulses “hop” or “propagate by *saltation*” creating a much faster impulse. (Drake & Vogl, 2004)

Nerve Fiber Types

Peripheral nerve fibers are categorized according to their diameter into three groups: A, B and C. Each nerve fiber type also has different characteristics. Group A fibers have a large diameter and are myelinated, therefore having a high conduction velocity. The “A” group consists of both motor and sensory neurons of four different types: alpha fibers (afferent or efferent), beta fibers (afferent or efferent), gamma fibers (efferent) and delta fibers (afferent). The “B” group consists of antonomic nevous system *preganglionic* fibers. They extend from the CNS to the ganglion and are divided into sympathetic and parasympathetic divisions. These fibers have a small diameter and a lower conduction velocity, although they are myelinated. Group “C” fibers are both the autonomic nervous system *postganglionic* fibers and *dorsal root* fibers. They are unmyelinated with small diameter and low conduction velocity. The postganglionic fibers extend from the ganglion to the effector organ, and are divided into parasympathetic and sympathetic groups. The *dorsal root* fibers carry sensory information for pain, temperature, touch, pressure and itch stimuli. (Purves & Augustine, 2001; Netter, 2010)

The Motor Neuron

The motor neuron, or efferent fiber, innervates a muscle cell. Three categories of motor neurons exist: *somatic*, *special visceral* and *general visceral*. (Purves & Augustine, 2001) In this text I will only speak of somatic motor neurons to which this text concerns. Somatic motor neurons project their axons from the CNS to the skeletal muscle cell, attaching to the muscle by the neuromuscular junction, where synapses on the muscle occur. (Drake & Vogl, 2004)With enough stimulation from the CNS, the motor neuron releases neurotransmitters that bind to the postsynaptic receptors to trigger a response in the muscle fiber, leading to muscle movement.

The Motor Unit

A motor neuron may synapse with one or more muscle fibers. The motor neuron and the muscle fibers it activates is called a “motor unit”. Motor units have three categories: *slow*, *fast-fatiguing* and *fast-fatigue-resistant*. (Purves & Augustine, 2001) *Slow motor units* stimulate slow-contracting muscles and apply a small amount of force, but are resistant to fatigue. These motor units sustain contractions for postural muscles. *Fast-fatiguing* motor units supply muscles that use a lot of force but fatigue quite fast. These motor units are usually required for quick bursts of energy like sprinting or jumping. *Fast-fatigue-resistant* motor units are required for slower movements that require a greater force. These muscle contractions can be sustained much longer. (Purves & Augustine, 2001)

Reflexes

Reflexes have an important objective clinical significance in neurological testing by determining the extent of the lesion that occurred either in the CNS or the periphery. A reflex is modified by a "reflex arc" (neural pathway) and is an involuntary and instantaneous reaction to a stimulus. Typically during testing, decreased reflexes indicate a peripheral lesion (*monosynaptic reflex*), whereas exaggerated reflexes indicate a central lesion (*polysynaptic reflex*). The following two reflexes are a *monosynaptic reflex*, which means the synapses are subjected only to the spinal cord, and not the brain. (Purves & Augustine, 2001)

The deep tendon (*myotactic* or *"stretch"*) reflex is a peripheral reflex that occurs when the muscle spindle apparatus inside the muscle is stimulated, resulting in contraction of this muscle. Peripheral reflexes synapse directly in the spinal cord – where the sensory neuron synapses onto a motor neuron – this results in a much faster response than if it went to the brain. Although the brain does receive information, it is usually only sensory at the same time the motor reaction is occurring. (Purves & Augustine, 2001) In contrast to the *myotactic* reflex is the *Golgi tendon reflex,* another monosynaptic reflex, but which reacts in the opposite manner; by lengthening the muscle in response to a stimulus. The purpose of the Golgi tendon reflex is to control muscle tension by relaxing the muscle before the force becomes great enough to potentially damage the tendon. This is a protective feedback mechanism. It occurs when the sensory neuron synapses onto an inhibitory interneuron which then synapses onto the motor neuron. The Golgi tendon reflex has the ability to override the myotactic reflex. (Purves & Augustine, 2001)

Superficial reflexes are another type of motor reflex in which the motor neurons respond to the deep scraping of the skin (*Babisnki, reflex, Jester's*). This type of reflex is an example of a *polysynaptic reflex,* meaning that the synapse must not only reach the spinal cord, but also the brain. The pathway of a polysynaptic reflex is complex, requiring either processing or inhibition of the reflex inside the brain. Superficial reflexes are inhibited when the pathway between brain and spinal cord have been damaged, usually after damage to the spinal cord. (Purves & Augustine, 2001)

Nerve Plexuses

There are two regions where the spinal cord enlarges: the cervical and the lumbosacral enlargements. (Netter, 2010) These correspond to the roots of plexuses where they extend from the spinal cord as branches into the extremities. The cervical enlargement corresponds to the brachial plexus, from spinal cord segments C4-T1 that innervate the upper extremities. The lumbosacral enlargement corresponds to the lumbosacral plexus that innervate the lower extremities. This plexus comprises the spinal cord segments L2-S3 and is found at the vertebral levels of T9-T12. (Netter, 2010; Drake & Vogl, 2004)

Myotomes and Dermatomes

Nerves that exit the plexus innervate the extremities to create *myotomes* and *dermatomes*. A myotome is a single nerve root that innervates a group of muscles (motor). A dermatome is the area of skin that is innervated by the single nerve root (sensory). (Purves & Augustine, 2001) For example, the myotome of an L5 nerve root would supply the following muscles: m. gluteus medius, m. gluteus minimus, m. tensor fascia latae, m. tibialis anterior, m. tibialis posterior, m. extensor digitorum brevis and m. extensor hallucis longus. The dermatome of L5 would be the lateral aspect of the thigh, the anterior aspect of the shin and the medial aspect of the dorsum of the foot.

2.3 Disease

Degenerative Disc Disease

Degenerative disc disease affects one or more of the intervertebral discs in the spine. It is a condition that can be extremely painful and have negative effects on the quality of one's life. While disc degeneration is a normal part of aging, it has been found to occur as early as in the teenage years. (Shankar, 2004) Many individuals are unaffected by the symptoms of this aging process, other individuals have accelerated degeneration which develop into severe chronic pain, spinal stenosis, disc herniation and arthritis. For these individuals this condition is known as "degenerative disc disease".

The disc undergoes certain histologic changes during the normal aging process. At infancy, the *annulus fibrosus* gets increasingly hyalinized with collagen fibers. By the second decade, norochordal cells of the nucleus pulposus shows gradual replacement with chondrocytes. By the third decade, the endplates (which are vascularized) show de-vascularization. By the fourth decade, the mismatch of cell death and cell proliferation develops – here the disc starts thinning due to formation of fissures and tears that allow invasion of vasculature. By the sixth decade the disc is finally replaced with fibrocartilage (Conventry, 1945) – this is the reason why elderly patients are less prone to having disc problems, although they are more prone to have pain that usually results from facet osteoarthritis.

Degeneration of the disc is believed to be caused by multiple biomechanical factors; cell death, loss of proteoglycan (glycosylated protein of connective tissue) and water content lead to bulging and collapse of the disc. This is a progressive process which eventually leads to an increased transfer of stress to the facet joints, accelerating cartilaginous degeneration, hypertrophy and osteophyte formation. (Shankar, 2004) Consequently, the ligamentum flavum (a main supporting ligament of the spine) hypertrophies and buckles. The combination of these occurrences affects the spinal canal circumference by narrowing it (spinal stenosis). Once the canal becomes too narrow for the spinal cord, the compression of nerve roots occurs – resulting in radiculopathy and sensorimotoric deficit of the extremity. (Djurasovic,2010)

Progression of the Disease

Degenerative disc disease is a progressive disease, thus there are multiple problems of ongoing degeneration that can complicate the disease process. Acc. to Shankar et.al., MRI findings of disc degeneration include: disc space narrowing, T2 weighted signal intensity loss from the intervertebral disc, presence of fissures, vacuum changes and calcification within the intervertebral disc, ligamentous signal changes, marrow signal changes, osteophytosis, disc herniation, malalignment and stenosis. (Shankar, 2004) In this text, I will discuss types of disc herniation, the spinal stenosis, the development of osteophytes, neurogenic claudication and neurogenic affects – all of which are *some* of the more common symptoms of degeneration.

Disc Herniation

Herniation of the disc results when compromise of the annulus fibrosis or endplate of the vertebral body leads to a loss of restraint to the opposing force of the nucleus pulposus. (Bobinsky & Ryan, 2010) This can be due to any secondary trauma or a "weak spot" – tears or fissures in the endplate or annulus fibrosis, or a dehydrated disc. Unbalanced pressure compromises the intrinsic ability of the disc to oppose extrinsic forces, which results in weakening of the disc. Consequently, this leads to rupture or herniation of the disc, decreased disc height as well as changes in bony structures – as they too must compensate for the pressure imbalance inside the disc. (Humpreys, 1999) It should also be noted that fragments of nucleus pulposus within the epidural space can induce a focal inflammatory reaction that can secondarily irritate the adjacent nerve root.

(Table 1.) ***Terminology Related to Degeneration of a Disc***

Osteophytosis

"Bone spurs" or *osteophytes* are commonly seen on MRI in patients who have disc degeneration. Inflammation or damaged tissue pathologically influences bone renewal and growth in the area where bone is involved. Osteophytes are round and scalloped in shape. (Goodman & Fuller, 2009) The term "disc-osteophyte complex" refers to the pathological extension of intervertebral disc material to the osteophyte formation. The disc almost always extends further than the osteophytes and into the neural foramen where it can cause irritation.

Spondylolisthesis

Spondylolisthesis can occur as a result of degenerative disc disease or it can be a congenital defect. In this condition, there is slipping or displacement of a disc due to weakness of the connective tissue. It can happen to one or more discs. It is characterized by the so called "napkin-ring" effect it creates as it compresses the spinal cord. The displacement can be anterior, posterior, or to the side. (Goodman & Fuller, 2009) Sideway displacement of multiple discs can lead to a very painful condition known as *degenerative scoliosis*; it most cases the displacement is anterior.

Spinal Stenosis

Spinal stenosis is a term used for the narrowing of the spinal canal that can occur in any region of the spine. Stenosis may be congenital or it can be caused by disc herniation, osteoporosis or a tumor constricting the canal. It is most dangerous to occur in the cervical spine, because spinal stenosis can impinge the spinal cord. (Purves & Augustine, 2001) Usually stenosis compresses nerve roots, but in lumbar stenosis the narrowing can result in compression of the *cauda equina* which results in bowel and bladder dysfunction (cauda equina syndrome). Symptoms of 94% of patients who have spinal stenosis have pain during periods of standing. (Klippel & John, 2008) *Neurogenic claudication* is a common term for nerve root compression in cases of lumbar spinal canal narrowing (lumbar spinal stenosis). (Goodman & Fuller, 2009)

Radiculopathy vs. Neurogenic Claudication

Neurogenic claudication should be distinguished from vascular claudication that is caused by vascular disease. Neurogenic claudication is associated with lumbar stenosis or spondylolisthesis. (Goodman & Fuller, 2009) The nerve root at a level of the spine becomes congested in the small space of the spinal canal. This leads to deficit of the affected nerve root. The lumbosacral nerve roots or the *cauda equina* are usually affected. Often, the pain feels like cramping of muscles, and is usually brought on by walking.

Taking breaks between walking – with unusual postures like stooping – is relieving for the patient. When one nerve root is compressed, it can affect a pattern of different areas to which it supplies. The sensory branches of the affected nerve root will cause pain, burning, numbness and tingling. (Goodman & Fuller, 2009) Over time, the muscles supplied by the motor branches of the nerve root will begin to atrophy, causing paresis – also affecting peripheral reflexes. *Radiculopathy* has similar origin to neurogenic claudication, because both involve compression of nerve roots, although the difference is that radiculopathy is usually associated with a herniated disc. (Purves & Augustine, 2001) Also, radiculopathy is usually unilateral, whereas neurogenic claudication is bilateral. (Goodman & Fuller, 2009)

Inflammation and even the slightest instability can cause muscular spasm in the low back. The muscle spasm is the body's attempt to stabilize the low back. (Travell & Simons, 1992) It is a reflex, and although the body's response of muscle spasm is not necessary for the safety of the nerve roots, it can be quite painful. Muscle spasm causes pain and movement restriction.

The Pain Symptomatology

Pain is intermittent, although it is usually not progressive – the disc degeneration is. Although the disease can be a chronic painful condition, the pain often remains "bearable" and at the same level most of the time – this type of pain is called "low amplitude pain". On occasion, the patient will experience sporadic flare ups of high intensity pain. (Bobinski & Ryan, 2010) Intervention of treatment of the pain is usually administered before it worsens. (Klippel & John, 2008) Pain can be caused by structures compressing the nerve root or spinal cord; or the pain may arise from secondary irritation of the nerve root from inflammation; (Humpreys, 1999) the pain can also be from directly inside the disc itself – nociceptive pain that is stimulated by the receptors within the annulus fibrosis – this type of pain is known as *discogenic pain*. (Purves & Augustine, 2001)

There are one of three ways in which the pain in degenerative disc disease can start: (1) a major injury followed by a sudden and unexpected pain, (2) a trivial injury followed by sudden back pain, and (3) pain that starts gradually and gets progressively worse. (Bobinski & Ryan et.al., 2010) The pain may be felt either asymmetrically or bilaterally.

Pain is usually asymmetrical in radiculopathy (ie. herniated disc) and bilateral in neurogenic claudication (ie. spondylolisthesis). (Goodman & Fuller, 2009)

Theory of Degeneration

The *"degenerative cascade"* of degenerative disc disease was first postulated by Kirkaldy-Willis in the 1970's. He proposed that after a torsional (twisting) injury to the disc, the disc would degenerate in three phases:

- *Phase One:* Significant dysfunction caused by the acute back pain of the injury.
- *Phase Two:* A long phase of relative instability at that particular vertebral segment. During this phase, the patient will have intermittent bouts of back pain.
- *Phase Three:* The body re-stabilizes the segment and the patient experiences fewer episodes of back pain.

He observed that these phases occurred over a period of 20-30 years. He concluded that by the sixth decade, elderly adults were less likely to have disc problems, but more likely to suffer from osteoarthritis of the facet joints. The disc problems were mainly seen in younger adults in their 30s-50s. (Klippel & John, 2008)

The process of degenerative disc disease is complex and it is still not fully understood. (Rajasekaran, 2004) Still, there are countless factors in the process of degeneration that create pain. For the patient, there is an endless list of confusing terminology. The terms radiculopathy and "sciatica" are used interchangeably that I believe can be misleading in the treatment of the disease. Below, I created a simple chart to put into better perspective the process of degenerative disc disease.

(Picture 1.) ***The Process of Degenerative Disc Disease***

2.4 Etiopathogenesis

"Degenerative disc disease is still a poorly understood phenomenon because of the lack of availability of precise definition of healthy, ageing and degenerated discs. Decreased nutrition is the final common pathway for degenerative disc disease and the status of the endplate plays a crucial role in controlling the extent of diffusion, which is the only source of nutrition." (Rajasekeran, 2004) It has been found that lack of disc diffusion accelerates the disease process. In a study of the absence of diurnal variations in older degenerated discs, Rajasekaran concluded that any degree of inability to perform fluid exchange is a key element in degenerative disc disease. (Rajasekaran, 2004) When the disk is dehydrated, it is not as resilient as normal. The fibrous tissue, which holds the disk material in place, may suffer small tears. These tears lead to further damage. The intervertebral disc is an avascular structure, meaning that it replaces its nutrients by diffusion with the endplates. If this balance is disturbed, due to micro-tears in the disc for example, the invasion of vasculature creates an imbalance of cell nutrients, cells, and DNA, leading to cell death or abnormal bone growths such as osteophytes. (Klippel & John, 2008) Another study found that those who had symptoms of degeneration also had decreased diffusion to the disc; whereas asymptomatic individuals had better diffusion to the disc. (Shankar, 2004)

Certain factors have been found to increase the risk of degeneration to the disc. These factors include age, family history of the disease, athletic activity and back injury. (Goodman & Fuller, 2009) There is some evidence that genetics may play a part in causing the degeneration and that osteoarthritis increases the rate of degeneration. *Patients who were diagnosed with herniated discs before the age of 21 were four to five times more likely to have a significant family history for disc herniation. Patients with significant osteoarthritis of the extremities have a greater degree of osteoarthritis and disc degeneration of the spine. Furthermore, there may be a genetic link between disc degeneration, degenerative scoliosis, and spondylolisthesis through similar cellular processes.* (Shankar, 2004)

2.5 Clinical Picture

The clinical picture of a patient with degenerative disc disease is dependent on the severity or type of the degeneration. (Bobinski & Ryan, 2010) On MRI, there may be bone spurs, osteoarthritis, and stenosis, shrinkage of the disc or disc herniation. If there is inflammation, herniation, prolapse, structural imbalance or loss of intrinsic pressure to the disc, as well as canal narrowing – there is most likely to be compression of the covering of the spinal cord or nerve root, transmitting radiating pain down the extremity. (Shankar, 2004)

Neurological Symptoms & Pain

There may be one or more nerve roots that become compressed or injured. The initial symptoms may be pain, numbness, tingling "pins and needles", or burning sensation. This may affect the extremity either unilaterally or bilaterally. It is more commonly affected bilaterally if there is compression on the *cauda equina*, since multiple nerve roots are concentrated here. (Goodman & Fuller, 2009) The pain can be intermittent or constant. It may be worse at a certain time of day. A compressed *cauda equina* or the segments below the lumbar spine will affect bowel or bladder function – in this case the low back pain may worsen when the patient coughs or sneezes. If there is compression in the cervical spine, this can be very serious condition resulting with *myelopathy* and general muscle weakness. (Klippel & John, 2008) Certain positions may worsen the pain depending on the direction of the compression. Positions that release the compression will be the patient's chosen position. Generally, relief is found in flexion of the lumbar spine in positions like sitting, or bending forward, but in some cases it may be extension or lying on one side. Some patients feel pain or "catching" in the low back when moving from sitting to standing, when walking, or even during prolonged standing. Compression of nerve root may lead to paralysis of the extremity, leading to atrophy of muscles. The beginning of this is seen as "clumsiness" during walking. Radiculopathy causes numbness, weakness or difficulty controlling muscles. (Goodman & Fuller, 2009)

(Table 2.) *Clinical Picture of Nerve Root Syndromes in the Lumbosacral Spine*

L5 Radiculopathy

L5 Radiculopathy is the most common form of radiculopathy affecting the lumbar spine. It presents with radiation of pain down the buttock to the lateral part of the leg, anterio-lateral part of calf and medial part of dorsum of foot. On examination, there is sometimes weakness in dorsiflexion of the foot, extension of the great toe, and foot eversion. Weakness of leg abduction may be present in severe cases involving the m. gluteus medius and m. gluteus minimus. (Goodman & Fuller, 2009) Atrophy or weakness of the muscles include: m. extensor digitorum brevis, m. extensor hallucis longus, m. tibialis anterior – resulting in "foot drop" during gait. Sensory loss is localized on the lateral aspect of the lower leg and dorsum of the foot. Sensation loss may be obvious when testing sharp sensation of the web space between the 1st and 2nd toes. Reflexes may or may not be absent (the internal hamstring reflex may be diminished on the symptomatic leg). (Klippel & John, 2008) Studies of electromyography testing in the L5 muscles of patients with radiculopathy of the involving nerve root show abnormalities of nerve conduction. These muscles are the following: m. gluteus medius, m. gluteus minimus, m. tensor fascia lata, m. tibialis anterior, m. tibialis posterior, short head of the m. biceps femoris, and the L5 paraspinals. Sensory studies show that the *sural* and *peroneal* nerve responses are normal since the lesion is almost always proximal to the dorsal root ganglion. (Shankar, 2004)

Muscular Imbalance & Disturbed "Co-activation" in Low Back Pain Patients

The kinetic chain of the feet, knees and pelvis correspond to the low back; therefore any muscle imbalance, injury or misalignment to these areas can have direct impact on the spine. (Vickery & Moffat, 2011) For example, the arches in the feet act as shock absorbers during gait and take a majority of the weight and pressure off this kinetic chain; if the feet are in hyperpronation ("flat foot") and the arch is lost due to muscle weakness, the missing absorbency may cause the force to be transferred into the low back. Another example is leg length difference either of functional or anatomical origin; the asymmetry results in an unbalanced pelvis (lateral tilt), that can cause scoliosis of the spine, consequently relating to muscle imbalance.

Muscle imbalance of the core and breathing muscles and the relation to low back pain has been noted in several of the works of Janda, Lewit, Kolář, Vele, Liebenson, and others. The spine requires support from the ligaments and "core" muscles that surround it. In the works of Lewit, he describes the "core" of the trunk as a neurologically-connected group of four different muscles: m. transversus abdominis, m. multifidus, m. diaphragm, and the pelvic floor. (Lewit, 1993) Research at University of Queensland in Australia found that *"not only were these muscles often poorly activated both in intensity and speed of contraction in low back pain patients, but they were also involved in both posture and respiration".*

According to Professor Pavel Kolář, the diaphragm is important in providing both trunk stabilization and respiration function. During the breathing pattern, the activity of m. transversus abdominis and the rest of the abdominal muscles are pulled down towards the spine during inhalation. Therefore, weakness of abdominals – particularly m. transversus abdominis – can easily be seen due to absence of this phenomenon. Both the m. transversus abdominis and m. multifidi along the spine should work together, subsequently stabilizing the spine and pelvis and decreasing the pressure on the vertebral discs, even by 40%. (Vele, 2006, pg 219)

In a study by Liebenson et al. it was found that LBP patients tend to have dysfunction of uncoordinated agonist-antagonist muscles – particularly of the "core" stabilizers; with incoordination comes instability of movement. This muscular instability then greatly affects the abrupt and sudden loads that are predisposed on the spine during daily activities. (Liebenson, 2006) thus contributing to disc herniation, pulled or overused muscles around the spine and other injuries. The ideal picture is to have co-contractions of these agonist-antagonist muscle chains because they greatly enhance the stability of the spine. (Liebenson, 2006) Co-contractions have been found to increase spinal stability by 36 to 64%. The presence of co-contractions allows the muscles to respond rapidly to great forces and unexpected movements. (Leibenson, 2006)

Recent research has indicated that core muscle training has become one of the most important focuses in fitness training. It has also shown that crunches and sit-ups do not actively stimulate the core; rather there are certain specific exercises that engage these muscles more effectively. Increasing numbers of athletes in all sports have come to realize that core training improves performance and *reduces* injury.

2.6 Prognosis

Several case studies suggest that the prognosis for patients with lumbar disc herniation radiculopathy receiving conservative management is good, although studies focusing on exercise-based management of patients with chronic lumbar disc herniation radiculopathy are scarce. (Hahne & Ford, 2006) The disease is usually manageable with various conservative treatment options, and does not necessarily require surgery. (Bobinski & Ryan, 2010)

The outlook of degenerative disc disease, radiculopathy, and sciatica depends on the severity of the condition, its precise cause, and the interventions used to treat the patient. When patients respond to conservative treatments, the result can be complete healing. (Goodman & Fuller, 2009) Without physical therapy, most disc diseases are extremely hard to treat, and in most cases only get worse with time. (Hahne & Ford, 2006) In patients who are treated regularly with physical therapy and take precaution to their health and fitness, back pain symptoms may flare up periodically, but don't get worse over time. (Bobinski & Ryan, 2010)

Early use of non-operative care will speed the healing process. The length of time that non-operative treatment will be required varies greatly from patient to patient. (Bobinski & Ryan, 2010) Avoiding injury can prevent further degeneration to the discs and it may help slow the disease process – this means staying away from aggressive sports or activity that involves extreme torsional movements of the spine. When the disease already exists, aggravation of existing symptoms can be avoided by limiting stressing or overusing the involved spine. (Vickery & Moffat, 2011)

2.7 Current Therapeutic Approach

Goals of the Therapy

- Pain management
- Ability to engage in exercises and rehabilitation program without pain
- Promoting proper ergonomics and posture to prevent excess stress on the disc
- Being able to manage the low back pain and maintaining the ability to function at home, work, in sports and during daily activities. (Burton, 2006)

Treatment Approaches

Conservative therapy is most commonly the first choice of treatment for those suffering from low back pain due to degenerative disc disease and radiculopathy. (Burton, 2006) Physical therapy is a crucial part in the healing of radiculopathy or disc disease. (Burton, 2006) As several treatment plans recommend bed rest, this is becoming a controversial issue in physiotherapy because lack of movement is thought to prevent further progress in the development of muscular strength, stability and active movement of the spine. (Leibenson, 2011; Stuempfle, 2007) Some institutions recommend maximal 1-2 days of bed rest. (Stuempfle, 2007)

Each patient is treated according to his or her needs, body type, symptoms, medical history, occupation and any other factors. An exercise routine is individually tailored to the specific situation, working to strengthen the muscles supporting the spine, while also increasing flexibility. Strengthening “core” muscles and increasing flexibility are both very important in the full recovery of the lumbar spine; as this releases compression to the nerve allowing it to heal. (Leibenson, 2006) Re-education of movement patterns is an important aspect in treatment since in a lot of cases the patient will clinically present with muscle imbalance and dysfunction of co-activation of agonistic-antagonistic muscle chains – the “core” stabilization system is of great importance in the stability of the spine. Strengthening the “core” and re-educating proper movement patterns is crucial to the therapy of individuals who suffer from back pain. (Janda, 2013; Leibenson, 2006)

- Physical therapy – gait training, Pilates-based exercise, instruction of proper body mechanics and posture, ROM and stretching exercises, Soft tissue and joint mobilization, strengthening and pain relief exercises, PIR according to Lewit, PNF according to Kabat, McKenzie method, antalgic positioning, therapeutic exercise, “Core” stabilization, modalities, dynamic lumbar stabilization, motion analysis, education of sensory-motoric training, joint mobilization, traction.
- Acupuncture relieves pain by activation of the gate-pain mechanism in the CNS.
- Light exercise – stretching, swimming, walking, bicycling, yoga, breathing exercises
- Ultrasound may be used to warm the area, which in turn brings blood flow and healing nutrients to the area.
- Drug therapy – corticosteroids, pain-killers, NSAIDs, Anti-depressants, anti-seizure drugs, muscle relaxants, opioids, osteoporosis drugs, narcotics.
- Electrotherapy – Transcutaneous Electrical Nerve Stimulation (TENS), Interferential current (IFC), Galvanic stimulation (GS), High-power laser therapy
- Interventional Pain Management – Epidural steroid injection, Selective nerve root injection, Facet joint injection, Sacroiliac joint injection, Joint and soft tissues injection
- Physiatry – interventional pain management, heat and cold packs, electrotherapies, massage, biofeedback, traction and therapeutic exercises.
- Behavioral medicine
- Back braces and special positioning devices

An interesting study that involved the intervention of joint mobilization of the lumbar spine in disc disease has proven good outcome and reliability as to improve diffusion to the degenerated disc: “*The stimulus provided by lumbar joint mobilization may influence the diffusion of water in degenerative IVDs at L5-S1; Following lumbar joint mobilization, a significant increase (*P *= .002) in the mean values for diffusion of water was* *observed within degenerative IVDs at L5-S1 (22.2% increase; effect size, 0.97)"*. (Beattie, 2008)

Research on individuals who had radiculopathy pain – some having treatment and others none – found that there was improvement of the symptoms over a 2-6 month period regardless of the treatment received. But there was persisting and recurring pain in 53% of individuals who had no treatment. 20% of individuals with sciatica symptoms proceeded to surgery within 6 months of the initial onset of pain. (Mathers, 2011)

Most neck and back pain responds to conservative therapy, but if the pain is unrelenting, severe, or associated with a radiculopathy or myelopathy, imaging is indicated to look for a treatable cause that may involve surgery. (Bobinski &Ryan, 2010)

3 Case Study

3.1 Methodology

The case study was conducted over a period of two weeks. The patient was placed under my care during the end of the first week. This limited me to seven days of physical therapy with the patient – two of which were weekend days during which the patient practiced self-therapy according to a treatment plan. The patient gave full and informed consent and approval of the project of the thesis by the Ethics Committee of the Faculty of Physical Education and Sport at Charles University in Prague.

Testing devices:

- tape measure
- goniometer
- reflex hammer
- tuning fork
- (scales were not able to be utilized for the double-scale test since the facility was not able to supply two exact matching scales; therefore this test was not performed)

Therapeutic Procedures Used in the Treatment of the Patient:

- McKenzie pain centralization technique (extensions of the spine)
- PIR by Lewit
- Joint Play by Lewit
- Soft tissue manipulation by Lewit
- Counter-pressure for release of TrPs
- Sensory-motoric stabilization by Janda
- Breathing exercises using developmental kinesiology position (Vojta)

The McKenzie Method:

The McKenzie Method of Mechanical Diagnosis and Therapy, invented by Robin McKenzie PT, MT, MDT., is a proven and internationally-used method that comprises an overall program of assessment, treatment and prevention strategies that are used in patient diagnosis for back pain, specifically in cases involving disc herniation with radiculopathies. *It is a standardized approach to both the assessment and treatment of low back pain and/or leg pain.* (McKenzie, 2011) In the 1960's, McKenzie noted during his practice that extending the spine could provide significant pain relief to certain patients and allow them to return to normal daily activities. The approach involves specific exercises that help "centralize" pain by directing it away from the extremity to the site of origin (the spine). The theory of the "centralization" mechanism is that the source of the pain is treated, rather than the symptoms. The goal is to teach the patients how to treat themselves to manage pain with specialized exercises. (McKenzie, 2011) The easy exercises also make it a good tool for patients to perform at home as an emergency treatment on an acutely "pulled back".

3.2 Anamnesis

Patient Anamnesis:

Person diagnosed: K.H., male **Year:** 1983

Diagnosis: (ICD-10: M51.1) Disease of lumbar intervertebral discs with L5 radiculopathy

Diagnostic Summary: The patient is experiencing an acute exacerbation of chronic low back pain due to disc prolapse in lumbosacral spine and radiculopathy irritation syndrome L5 in the right leg, with light sensorimotoric deficit. On MRI there was dorsomedial prolapse of the disc L3/L4 (size 3) with pressure on the dural sac; right side paramedial prolapse of the disc L4/L5 (size 6.5mm) with pressure on the dural sac and root of L5 on the right side.

Weight: 93 kg (no changes)
Height: 183 cm
Breathing Rate: 13 per minute
Blood Pressure: 131/75 mmHg
Temperature: 36.4
Pulse: 70
Mental state: the patient is oriented, optimistic and motivated.

Related Subjective Information to the Diagnosis:

- Location of pain: Low back, with burning sensation to R leg on the back side, sometimes down to the toes ventrally.
- Pain type: Chronic, intermittent, burning.
- Facilitating/ alleviating factors: Sitting up straight with good posture and lying on the belly is alleviating. Lying on the L side and on the back is worsening.
- Duration of pain (intermittent, morning, evening): Worse in the morning; constant feeling that something is pressing in the low back.
- ADL movement restrictions: Cannot touch toes without having to bend the knees. Feels restricted when bending to the left side.
- VAS Pain Score (0-10): 2/10 when sitting upright; 4-8/10 during the rest of the day.
- Time of onset: Pain since 12 years old; Worsening in the past two months
- Previous Accidents: 12 years old, had an attack of pain in the low back; was so severe, he fell to the floor.
- Bladder/bowel problems: No

- Does the pain worsen when you cough or sneeze? No.

Family Anamnesis: mother had hypertension; grandfather died of intestinal cancer; grandmother died from melanoma; other grandfather is being treated for cancer of the bladder; both father and grandfather suffer from LBP and stenosis of the spinal canal.

Disease Anamnesis:

- Normal childhood diseases
- Inguinal hernia on the R side at age 6
- Ankle injury (2003) in right Achilles tendon rupture; used crutches; the patient reports that he was occasionally not using the crutches and instead hopping on the left leg.
- Hypertension - none
- Ischemic disease - none
- Diabetes - none
- Tuberculosis - none

Pharmacological Anamnesis:

Date Administered: (17-19.01.2013):

- Korylan tbl. 1-1-1-1

- Infusion (Time: 13:00-14:00): sodium chloride, natrium salicylicum biotika, guajacuran, novalgin

- Aulin tbl. 1-0-1

Date Administered: (20-23.01.2013):

- Aulin tbl. 1-0-1

- Infusion (Time: 13:00-14:00): sodium chloride, natrium salicylicum biotika, guajacuran, novalgin

Surgeries:

- Surgery of inguinal hernia on the R side, age 6

Occupation: Company director of Zenit; sitting most of the day; drives frequently. The patient is right-handed.

Sports: All his life was very active; before the last two months he was bicycling, swimming, on rugby team, playing tennis and other sports, but he had to slow down because of the pain. He can still swim (freestyle) without much discomfort, it actually helps with the pain. He also exercises at home where he has a small gym. He performs strengthening exercises for the core muscles on the ball (by balancing on the ball on the knees) and some stretching exercises.

Social: Lives in a flat on the first floor; Elevator: yes; The patient is right-handed.

Allergies: Pollen, dust, feathers – with asthma symptoms in the past – no medication.

Abuses: Non-smoker; occasional alcohol (socially).

Previous RHB: After ankle injury, in 2003, he went for intensive rehabilitation at Vojenský rehabilitační ústav in Slapy. The therapy included: electrotherapy, paraffin, swimming 120 laps daily; treatment was successful. Currently he visits three different specialists for his back pain. Dr. Nedelka in Trepy gives him pain pills and shock wave therapy. He has been seeing a chiropractor regularly since August, 2012 – treatment is manipulation of the spine for “re-alignment”. It is effective, but only temporary – the pain comes back after.

Assistive Devices: The patient wears reading glasses. He is using a pelvic support pillow for the low back during long-sitting periods that he received from his chiropractor (This pillow is triangular in shape and is sat on with the higher end under the ischium so that the pelvis is in anterior tilt; also the knees and hip are not kept at a 90 degree angle, it is more like 100 degree angle). This could potentially be harmful to the patient, because anterior pelvic tilt will increase the pressure that is already being put on the prolapsed disc in the direction of the prolapse (therefore causing relief) but only facilitating the faulty position of the disc; I would not recommend this device.

Patient's health documentation extract: In Sept. 2008, there was a CT-scan performed; there were three slipped discs present in the lumbar spine (L3-4, L4-5, L5-S1). In 2012 an MRI was performed at UVN. On this MRI there was a dorsomedial prolapse of the disc L3/L4 (size 3) with pressure on the dural sac; and a right side paramedial prolapse of the disc L4/L5 (size 6.5mm) with pressure on the dural sac and root of L5 on the right side. Assistive devices: the patient wears reading glasses.

Physician's indication towards RHB: Rehabilitation plan for chronic low back pain with L4-L5 radiculopathy; and infusion therapy.

3.3 Initial Kinesiological Examination

Status Praesens:

The patient is in neurology department for infusion therapy and rehabilitation of L5 radiculopathy to the right leg with chronic LBP. He has experienced intermittent back pain since he was 12 years old, when he had an acute attack of LBP and fell to the floor. The pain dissapeared after about a week. Since this time, the back pain has been on and off. The patient has had more than 10 attacks in the since then. In the past two months, the symptoms have worsened. The patient feels pain 4-8/10 during the day. In the morning it is worse. When walking approx.1500 meters, the pain is so intolerable that he must take a break. Also when standing for 1 min. the pain gets worse. Movement makes it better than standing still. Position of relief is squatting position. Positions that worsen pain are lying on the left side and exagerating lordosis in the lumbar spine.

Examination Proposal:

- **Aspection of posture**
    - Breathing Pattern

- **Pelvic Examination + Other tests**
    - Palpation of SIAS, SIPS
    - Overtake phenomenon
    - Scale test
    - Patrick's test (piriformis)
    - Trendelenburg Test
- **Spine distances**
    - Shober's distance
    - Latero-flexion
- **Gait**
    - Walking naturally
    - Walking in straight line
    - Tip-toes
    - Heels
    - Squatting walk
- **Basic movement patterns**
    - Hip extension
    - Trunk flexion
    - Hip abduction
    - Neck flexion
- **Anthropometry**
    - Anatomical leg length
    - Functional leg length
    - Circumferences of leg
- **Palpation**
- **Active ROM**
- **Passive ROM**
- **Muscle Strength Testing**
    - Abdominals
    - Gluteals
    - Quadriceps

    - Tibialis anterior
    - Peroneals
    - Gastrocnemius
    - Extensor digitorum longus
    - Extensor hallucis brevis
    - Abductor hallucis
- **Joint Play**
    - SI joint
    - L-spine intervertebral joint segments
    - TF joint
    - Patella
    - Knee joint
    - TC joint, Chopard's, IPH, Calcaneus
- **Neurological Examination**
    - Deep Tendon Reflexes
    - Deep Sensation
    - Dermatomes
- **ADL assessment**
    - Lifting, sleeping, sitting positions

Aspection:

Anterior view: The patient has a typical kypohtic-lordotic posture of the spine. He stands with the R leg slightly posterior to the frontal plane. The R leg is slightly externally rotated and abducted, originating from the hip. There is lateral tilt of the pelvis with the iliac crest higher on the R side. The umbilicus deviates to the R side of the body. The R arm musculature appears to have more trophy than the L arm musculature. The R arm is held more posterior from the frontal plane. The R shoulder is higher than the L shoulder. – Possible handedness pattern on the right side.

Right Lateral view: The R leg is in slight external rotation and posterior placement from the frontal plane. Slight semi-flexion is present in the knee. The patient leans forwards at the hips, putting the weight more on the toes. Lumbar hyper lordosis and upper TH kyphosis is present.

Left Lateral view: The L leg is in better alignment with the frontal plane than the R leg was. Semi flexion is present in the knee. Lumbar lordosis and upper TH-kyphosis are evident.

Posterior view: The patient has a wide stance. The full body weight-bearing is placed more on the L leg. The R leg is placed on the floor more posterior to the frontal plane, while the L leg remains in frontal plane. The R leg is in slight ER and ABD. The iliac crest is higher on the R side. There is deviation of the lumbar spine to the L side, but from the TH-L crossing the thoracic spine deviates towards the R side – perhaps there is the beginning of scoliosis – it is as if the patient is leaning to the R with the torso, and using the right leg for support by moving it posteriorly; the right leg is kept at a diagonal placement from the left leg giving the patient stability so as not to fall backward and to the right side. The result is elevation (or possible torsion) of the pelvis. The popliteal line at the knee appears to be higher on the R side in comparison to the L side.

Active Movements of the Spine:

Forward Bend: The weight is placed on the heels as the patient bends forward. The pelvis does not remain in the frontal plane but deviates posterior from it. The lumbar spine remains flat as the patient moves, meaning he has restricted ROM in this region. The thoracic spine compensates for this restriction with hyper kyphosis. The patient cannot reach the floor. The forward bend is restricted by stiffness of the lumbar spine.

Side-Bending to the right: The legs are kept at a narrower base. The patient is able to side bend but moves the head into an extreme lateral position so that the cervical spine deviates from the thoracic spine directly at the C-TH crossing. The distance between the ear and shoulder is 3 cm. There is no movement of the lumbar spine, little movement of thoracic spine, and the cervical spine is hypermobile. This movement was restricted.

Side-Bending to the left: The patient puts more loading on the R leg as he attempts to bend to the left. He puts the L leg into abduction for stability. He leans slightly anterior to the frontal plane with the upper part of the body. The restricted ROM in the low back is being compensated for by abducting the left leg. There is more movement on this side, but abduction of the left leg is present. There is less use of the lumbar paravertebral muscles on the L side. Again, the cervical spine is hyper-flexed with the ear-to-shoulder distance being 2 cm from touching the right shoulder.

Backward Bend: This movement is painful for the patient, with the pain located in the low back. There is semi flexion in the knees as the patient bends backward. The pelvis moves forward and out of the frontal plane. The abdomen protrudes. The legs deviate anteriorly out of the frontal plane with the pelvis. It is almost as if the patient is trying to prevent any loading on the low back. The lumbar spine is restricted in movement due to pain.

Breathing Pattern (supine): The patient has an "upper" – thoracic breathing pattern; there is elevation and expansion of the ribs but little abdominal movement.

Pelvis Examination:

Palpation of ASIS/PSIS:

Anterior – the SIAS is higher on the patient's right side

Posterior – the SIPS is higher on the patient's right side

Lateral – the SIPS and SIAS on the both lateral sides are in anterior tilt.

- There is presence of lateral tilt of the pelvis on both sides, with the iliac crest being higher on the R side
- There is also presence of anterior pelvic tilt.

Other Tests: (Table 3.)

Spine Distances: (Table 4.)

Gait:

Walking naturally: The feet make a loud and heavy flapping sound during the gait, as the weight is forced down on the heel and then translated to the toes. The whole body weight-bearing is more on the left leg; the pelvis is slightly raised to the right side. The pelvis on the right side rotates anteriorly in a transverse plane. The umbilicus is deviated to the left side. There is pain present during the swing phase of the R leg. There is slight circumduction of the R leg during walking.

Walking in straight-line: The patient is able to perform this test without problems in balance or pain. There is rotation of the pelvis on the right side anteriorly. There is a tendency to lean to the left.

Walking on Tip-toes: The patient is able to perform this test without any pain or difficulty.

Walking on Heels: The patient is not able to perform this test. He has difficulty with heel-standing due to pain, and a pulling sensation in the back of the thighs.

Squatting walk: The patient is able to perform this test without pain, but with extremely wide base of the feet.

Basic Movement patterns:

Hip Abduction – In both the right and left legs there is an altered movement pattern with initiation of movement with m. illiopsoas and the tendency for ER of the leg; there is also flexion of the hip – this means that the m. rectus femoris is overactivated; the tensor mechanism is present. In the left leg there was elevation of the hip: Quadratus mechanism.

Hip Extension – The left leg has a correct pattern; the right leg pattern is in the correct form, but shakiness is present during movement. The patient reported pain that translated into the low back.

Trunk Flexion – The patient substituted with the hip flexors. The movement was quickly performed, with a rocking motion of the torso (like a block) during flexion and shaking of the weak abdominals. He had the tendency to move toward the left side. The patient was not able to perform complete trunk flexion. This pattern was altered due to weakness of abdominals and compensation by the m. illiopsoas.

Neck Flexion – Upon initiation of movement there was anteflexion of the neck. Neck flexion was initiated by the sternocleidomastoid muscle. This pattern is altered due to weakness of deep neck flexors and overuse of m. sternocleidomastoid.

Anthropometry: (Table 5.)

Examination of Skin and Fascia: (Table 6.)

Palpation: (Table 7.)

Muscle Length: (Table 8.)

Active ROM: (Table 9.)

Passive ROM: (Table 10.)

Muscle Strength: (Table 11.)

Joint Play (by Lewit): (Table 12.)

Neurological Findings:

Deep Tendon Reflexes:

- ***Achilles***

  Right: hyporeflexia, grade 0 **With reinforcement:** Absent

  Left: normoreflexia, grade 2+

- ***Plantar Flexors***

  Right: hyporeflexia, grade 0 **With reinforcement:** Absent

  Left: normoreflexia, grade 2+

- ***Patellar***

  Right: normoreflexia, grade 2+

  Left: normoreflexia, grade 2+

Deep Sensation:

- **Joint Position Sense** (arthresthesia)**:** negative
- **Vibratory sense** (pallesthesia)**:** negative
- **Perception of Movement** (kinesthesia)**:** negative

Sensation in Dermatomes:

Result: all were felt with the same intensity on both legs.

- **L1/L2**
- **L3/L4**
- **L5/S1**
- **S1/S2**

Lasegue Test:

Right leg: Positive at 45 degrees

Left leg: negative

Reverse Lasegue Test:

Right leg: negative
Left leg: negative

Initial Kinesiological Examination Conclusion:

The following list concludes the findings on the Initial Kinesiological Examination. The findings listed here are pathological. They are important value to the treatment plan and prognosis of the patient.

- Weight bearing is placed more on the left leg during stance.
- The right leg is slightly externally rotated and abducted, originating at the hip, due to shortness of m. gluteus medius.
- The right leg is placed more posterior in the frontal plane, by 2cm.
- There is slight semiflexion of the knee on the right side, due to shortness of hamstrings.
- There is hyper lordosis of the lumbar spine.
- Kyphosis is present in the upper thoracic spine.
- The right shoulder is higher and more muscle tone is present when comparing to the left side in the following muscles: m. upper trapezius, m. deltoid, and m. pectoralis major.
- The head is held in slight retro-flexion; the cervical spine is hypermobile in side-bending with the ear-to-shoulder distance being 2cm on the right, 3cm on the left. The reason for this is compensation of mobility of the spine due to restriction in the lumbar part.
- Latero-flexion of the spine is restricted on both sides, but more to the right side. The finger to floor distance is 14cm when bending to the R; 22cm when bending to the L side.
- Back extension was able to be performed, but with pain in the lumbar spine.
- Heel walking was unable to be performed, due to pain in the lumbar spine as well as pulling sensation in the back of thighs.
- From the posterior view, the lumbar spine deviates laterally towards the left, while the thoracic spine deviates laterally to the right. This is caused by the lateral and

anterior position of the illium on the right side. It is the beginning of C-curve scoliosis with convexity to the left side.

- Upon anthropometric examination, the right leg was found to be a difference of 2cm longer than the left leg in anatomical length.
- The right calf was measured to be 2cm less in circumference than the left calf. This is the beginning of atrophy of muscles due to sensorimotoric effect of L5 syndrome, in addition to less whole-body-weight loading on the right side.
- The functional leg length from the SIAS to malleolus medialis is longer by 2 cm on the right side due to leg length difference.
- The functional leg length from the umbilicus to malleolus medialis is different by 1 cm. less on the right side. The umbilicus is deviated to the right side due to atrophy of m. rectus femoris on the right side.
- Kibler’s fold caused a HAZ along the paravertebral region, with marked redness on the skin and translated a tingling sensation to the lumbar spine.
- The skin was restricted in the lumbar part in cranial and caudal directions.
- The fascia of the lumbar and thoracic spine was restricted in cranial and caudal directions.
- The skin of the lower extremity in the calf area of dermatome L5 was restricted in lateral direction.
- In basic movement pattern in hip extension the movement pattern was correct, but pain was translated to the lumbar spine.
- In the basic movement pattern in hip abduction – In both the right and left legs there is an altered movement pattern with initiation of movement with m. illiopsoas and the tendency for ER of the leg; there is also flexion of the hip – this means that the m. rectus femoris is overactivated; the tensor mechanism is present. In the left leg there was elevation of the hip: Quadratus mechanism.
- Palpation: There was increased tonus in both sides of the m. erector spinae with TrPs on the R side. The m. rectus femoris was hypotonic on the R side. The m. quadratus lumborum was hypertonic on both sides. The m. gluteus medius was hypertonic on the R side. The m. piriformis was hypertonic on the L side. The hamstrings on both sides were hypertonic, more in the m. biceps femoris on both

sides. Both heads of the m. gastrocnemius were in hypotone on the L side. M. illiopsoas was in hypertone, on both sides. The m. rectus femoris, m. vastus lateralis and m. tensor fascia latae were all in hypertone on both sides.

- Muscle Length: The hamstrings were shortened on both sides with pain to 40 degrees on the R side. The m. illiopsoas was shortened on both sides, but more on the R side. The quadriceps was shortened on both sides, more in m. vastus lateralis. The m. tensor fascia latae were very much shortened on both sides. The m. quadratus lumborum was very much shortened on both sides. The m. piriformis was very much shortened on the L side.
- Active ROM: In internal rotation of the hip, the R leg was restricted by 10 degrees, the L leg restricted by 5 degrees. In hip flexion with knee extension the L leg was restricted by 15 degrees and the R leg by 40 degrees. In knee extension, the R knee was restricted in extension by -5 degrees; In knee flexion both knees were restricted by 10 degrees. Hip abduction in the R leg caused pain in the low back at 45 degrees. Both ankles were excessive in plantarflexion by 5 degrees.
- Passive ROM: In internal rotation, both legs were restricted by 5 degrees (with soft barriers). In hip flexion with knee extension the R leg was restricted by 40 degrees (with pain) and the L leg by 10 degrees (with a soft barrier). In knee extension, the R knee was restricted by -5 degrees (with a soft barrier). In knee flexion both knees were restricted by 5 degrees; both ankles were excessive in plantarflexion by 5 degrees.
- Muscle strength testing: the lower abdominals and oblique trunk flexors were grade 3 and abductor halluces was grade 2-, signifying weakness of these muscles. The right gastrocnemius muscle was grade 4 compared to 5+ on the left side.
- The tibio-fibular joint on the right leg was restricted in a ventral direction
- In joint play examination the III., IV., and V. proximal interphalangeal joints of both right and left feet were blocked in ventral direction.
- The patella was restricted in caudal direction in both legs.
- Lasegue’s test was positive at the point of 45 degrees flexion of the hip.
- The Achilles and plantar reflexes on the right leg were unresponsive (hyporeflexive) even after elicitation of reinforcement: grade 0.

Conclusion Summary for the Purpose of Therapeutic Intervention: (Table 13.)

3.4 Short-term and Long-term Physiotherapy Plan

Short-Term Therapy Objectives:

- Centralize pain in lumbar spine
- Eliminate irradiating pain (radiculopathy)
- Improve ROM: spine movements in forward bend, backward bend, side-bend; hip IR and in hip flexion with knee extension.
- Improve mobility of skin and fascia in lumbar spine and thoracic spine
- Improve mobility of skin in L5 region of lower right extremity
- Eliminate TrPs in upper thoracic region on the right side
- Strengthen weak muscles: core muscles of abdomen (obliques, m. rectus femoris, m. transversus abdominis, m. multifidi, m. pelvic floor)
- Improve breathing pattern (activation of m. diaphragm, m. transversus abdominis, m. pelvic floor, m. multifidi)
- Stretch tight muscles: m. illiopsoas, hamstrings, quadriceps, m. vastus lateralis, m. tensor fascia lata, m. piriformis (L side), m. gluteus medius (R side)
- Mobilize blocked joints: tibiofibular on the right side, patella, IP joints of both feet
- Re-education of Basic Movement Patterns
- Teach the patient proper position of posture in ADL: sitting at desk, lifting, standing

Short-Term Therapy Plan:

- Soft tissue techniques for restricted skin and fasciae in the TH-L region in cranial-caudal direction with breathing.

- Pressure point release using counter-pressure with breathing for elimination of the TrP in upper thoracic region.
- Exercises for the spine using the McKenzie technique into extension.
- PIR for the following muscles: m. quadratus lumborum, m. illiopsoas, hamstrings (m. biceps femoris), quadriceps (m. vastus lateralis), m. piriformis (L side), m. gluteus medius (R side)
- Basic Movement Patterns of the hip abduction and hip extension
- Sensory-motoric Stabilization training according to Janda
- Joint mobilization by Lewit for the following: tibio-fibular joint in ventral direction on the right side; patella in caudal direction on both sides; the III, IV, V interphalangeal joints of the toes into ventral direction on both sides.
- Pelvic floor strengthening exercises (in the position of 3rd month baby in supine position by Vojta)
- Education of breathing exercises (with activation of m. transversus abdominis)

Long-Term Therapy Objectives:

- Eliminate pain in the lumbar spine
- Maintain muscle strength and ROM
- Get the patient back to sports and daily activities without pain
- Continue to improve muscle strength of deep core stabilizers of the trunk and pelvis
- Sensory-motoric Stability training
- Re-education of normal motor patterns
- Self-therapy exercises
- Improve posture and ergonomics in ADL

Long-Term Therapy Plan:

- Continue with exercises for the spine using the McKenzie technique
- PNF upper and lower trunk diagonals for strengthening abdominal muscles

- PNF pelvic diagonal for strengthening of abdominal obliques
- Strengthening exercises for the m. tibialis anterior, m. peroneals, m. extensor halluces longus, m. extensor digitorum and right side m. gastrocnemius.
- Self-therapy exercises: (exercises of the pelvic floor, breathing exercises, abdominal remedial exercises with anteversion of the pelvis, self-PIR for tight muscles, ROM exercises using the Theraband®).
- Sensory-motoric stabilization with practicing of the “small foot”
- Slowly progressing into sports – beginning with light sports such as swimming and bicycling .
- Shoe orthotics for the anatomical leg length difference

3.5 Therapy Progress

The patient was admitted as an in-patient to the neurological department on Thursday, 17.01.13. He was scheduled for an infusion beginning on the first day with no rehabilitation on this day, due to pain. Rehabilitation was scheduled for the following day on Friday, 18.01.13. The duration of the hospital stay lasted from 17.01.13 until 24.01.13. In total, there were five one-hour therapy sessions with the physiotherapist, and two days off (weekend). During the off-hours, the patient received infusions, painkillers, and a self-therapy plan that was prescribed by the physiotherapist. In the following sections are the day-to-day therapy protocols of the patient, including changed or modified therapy that was given to the patient either as a treatment or a self-therapy and the result of these implementations.

Day 1: Thursday, 17.01.2013 **Time:** 14:00

Status Praesens: The patient was admitted into the hospital at the department of neurology. His pain on the VAS scale was 6-8/10. The pain stems from the L4-L5 root with radiation into the L5 nerve root distribution.

Goals of Today's Therapy: No rehabilitation was prescribed for today. He was recommended by the physician to stay in bed rest; he was given an infusion and painkillers (see anamnesis).

Day 2: Friday, 18.01.2013 **Time:** 14:00

Status Praesens: Today was the initial meeting of the patient for the initial kinesiological examination and physical therapy. The patient is in much pain mostly in the low back, but the pain is sometimes radiating into the right lower extremity down to the toes. There is no numbness or tingling sensation, just pain. He feels the most pain during walking and standing for longer periods. His pain today on VAS is 5-8/10. The patient gave his consent to follow through with the initial kinesiological examination. The patient is optimistic, cooperative and motivated.

Goals of Today's Therapy: Take patient anamnesis and perform initial kinesiological examination. Prescribe short-term therapy and self-treatment according to the results of the examination. Reduce pain.

Implementation: The anamnesis and initial kinesiological examination were taken. Instructions were given to the patient about proper positioning during ADL – sleeping position, sitting position, and analgesic positions in the bed. When sleeping, the patient was asked to avoid lying on the painful side (L) and to lie on the belly if possible. In sitting position, the patient was asked to sit in an upright and neutral position, but to sit as little as possible so as not to overload the low back. The movements he should avoid are lying with the knees or hips flexed, or any position with flexion of the lumbar spine. The self-therapy treatment that was given was back extension exercises by McKenzie. The patient practiced this exercise and felt pain in the initial movement, but after a few repetitions the patient was more capable, and it became less painful for him to perform this exercise. The patient was prescribed this exercise in 10 repetitions every 2 hours (the exercise must be performed at least five times per day to have an effect) (McKenzie, 2011). The patient was assisted in modeling of the "small foot" for sensory-motoric stabilization – he practiced this in sitting position first, then in standing. The patient was also given a modified version of self-PIR by

Lewit for the hamstrings on both sides (using a towel to gently pull the leg into flexion in supine position). Another self-therapy treatment that was prescribes was PIR by Lewit for the illiopsoas. The PIR exercises were asked to be performed in sets of three, holding for 20 seconds, three times per day. Breathing exercises were also given as a self-therapy.

Therapy Summary:

- Soft tissue techniques of TH and L fasciae in cranial-caudal direction on both sides
- Pressure point release with breathing into TrPs in the right side upper thoracic region
- PIR of m. quadratus lumborum on both sides, (longer hold of breath on the right side)
- PIR of m. tensor fascia lata on both sides
- PIR of m. illiopsoas on both sides
- PIR of m. piriformis on the left side
- PIR of m. gluteus medius on the right side
- PIR of the quadriceps on both sides, with accentuation of m. vastus lateralis
- PIR of the hamstrings on both sides, with accentuation of m. biceps femoris
- Joint mobilization by Lewit for blocked joints: ventral mobilization of the tibio-fibular joint on the right side, caudal mobilization of the patella on both sides, ventral mobilization of the IP joints III, IV and V on both feet.
- McKenzie extension exercises (10+ repetitions)
- Practicing breathing exercises with activation of m. transversus abdominis
- Pelvic floor strengthening exercises (in 3 month baby position by Vojta)
- Sensory-motoric stabilization with practicing of the "small foot" first in sitting, then in standing.
- Educating the patient about ADL positioning and posture
- Demonstration and practicing of self-therapy exercises (see below)

Result: All the results from the Kinesiological Exam were recorded (see Initial Kinesiological Examination). The patient felt immediate relief after the McKenzie spine exercises and also after PIR on the tight muscles in particular. He reported that these muscles felt “not as tight and restricted” as before the therapy. The skin and fascias were less restricted in the lumbar and thoracic regions. The TrP in the upper thoracic region was released by counter-pressure with breathing. There was slight improvement of ROM after PIR, particularly after PIR of the piriformis muscle. The patient was able to perform the self-therapy exercises well. There was relief of pain after the initial treatment. The goal will be to continue the self-therapy over the weekend.

Self-therapy:

- McKenzie back extensions (10 reps., every 2 hrs. – breathe out during maximal extension, hold this for a few seconds)
- Modified Self-PIR by Lewit for the hamtrings. This exercise was modified by using a towel to assist with PIR of the hamstrings – knee extension with hip flexion in the supine position (3 reps., 3 times a day – hold for 20 seconds each repetition).
- Self-PIR by Lewit for the illiopsoas (3 reps., 3 times a day – hold for 20 seconds each repetition)
- Self-PIR by Lewit for the m. piriformis on the left side
- Self-PIR by Lewit for the quadriceps on both sides
- Pelvic floor strengthening exercises (in 3rd month baby position by Voijta)
- Breathing exercises (with activation of m. transversus abdominis).

Day 3: Monday, 21.01.2013 **Time:** 14:00

Status Praesens: The patient’s pain on VAS today, is 4/10. The patient reports pain being “about the same, maybe a little better”. He did the exercises that were prescribed to him over the weekend. The patient reports feeling a “pulling sensation” on the R side of the muscles in the trunk region during the McKenzie extension exercises.

Goals of Today’s therapy: Continue with exercises that were prescribed on the previous visit. Continue to decrease pain. Improve ROM. Correct breathing pattern exercise. Correct the position of patient during the McKenzie spine exercise.

Implementation: Active movements of the spine were asked to be performed: forward bend, side-bend, backward bend. Mobilization of the TH-L fascia was performed. The TrP in the upper thoracic region had disappeared since the last therapy. Joint play (by Lewit) was performed in individual segments of the lumbar spine and sacroiliac joint; the TF joint, patellae and the IP joints of both sides were also checked. The McKenzie exercises were asked to be performed by the patient alone, in case of necessary correction. This time, the therapist added manual "overpressure" to the lumbo-sacral spine, according to McKenzie. Ten repetitions of this exercise were performed in this way. Breathing exercises were also controlled. Muscle length testing for the tight muscles was re-checked.

Therapy Summary:

- Soft tissue techniques of TH and L fasciae in cranial-caudal direction on both sides
- PIR of m. quadratus lumborum on both sides, (longer hold of breath on the right side)
- PIR of m. tensor fascia lata on both sides
- PIR of m. illiopsoas on both sides
- PIR of m. piriformis on the left side
- PIR of m. gluteus medius on the right side
- PIR of the quadriceps on both sides, with accentuation of m. vastus lateralis
- PIR of the hamstrings on both sides, with accentuation of m. biceps femoris
- Joint mobilization by Lewit: ventral mobilization of the IP joints III, IV and V on the right side.
- Control of McKenzie extension exercises (10+ repetitions)
- Control of breathing exercises with activation of m. transversus abdominis
- Control of Sensory-motoric stabilization with practicing of the "small foot" performing steps.
- Control of pelvic floor strengthening exercises (in 3 month baby position by Vojta)

Result: Corrections of the breathing exercise were needed, as the patient did not hold the contracted position long enough during exhalation. The patient's posture during McKenzie spine extension exercises were also corrected by the physiotherapist. After examination of spine movements, there was improvement in the forward bend by 2 cm; there was also improvement in side-bending to the right side by 4 cm. There was increased mobility in skin and fascia along the spine in the lumbar and thoracic regions. In joint play, there were no blockages found in any of neither the lumbar segments nor the SI joint. The blockages in the patellae on both sides and the TF joint on the right side had disappeared since the last therapy. The normal muscle length for the m. piriformis was successfully reached; therefore PIR for this muscle will no longer be implemented.

Self-therapy:

- McKenzie back extensions (10 reps., every 2 hrs. – breathe out during maximal extension, hold this for a few seconds)
- Modified Self-PIR by Lewit for the hamtrings. This exercise was modified by using a towel to assist with PIR of the hamstrings – knee extension with hip flexion in the supine position (3 reps., 3 times a day – hold for 20 seconds each repetition).
- Self-PIR by Lewit for the illiopsoas (3 reps., 3 times a day – hold for 20 seconds each repetition)
- Self-PIR by Lewit for the quadriceps on both sides
- Pelvic floor strengthening exercises (in 3rd month baby position by Voijta)
- Breathing exercises (with activation of m. transversus abdominis).

Day 4: Tuesday, 22.01.2013 **Time:** 14:00

Status Praesens: The patient reports "feeling better than yesterday"; he is consistently performing the McKenzie spine exercises as well as the self-therapy as were prescribed. He has no problems with any of the exercises and finds them to be helpful. The pain is about 3-4/10 on VAS.

Goals of Today's Therapy: Continue with exercises that were prescribed on the previous visit. Continue to decrease pain, improve ROM and modify breathing pattern.

Implementation: Muscle length of the piriformis was checked again to make sure there were no changes since the last therapy. Muscle length testing was performed on the tight muscles. Lasegue's test was performed. Joint play in the lumbar segments and SI joint were checked as well as the TF joint on the right side, both patellas and IP joints of both feet. Control check for all of the exercises was made by the physiotherapist.

Therapy Summary:

- Soft tissue techniques of TH and L fasciae in cranial-caudal direction on both sides
- PIR of m. quadratus lumborum on both sides, (longer hold of breath on the right side)
- PIR of m. tensor fascia lata on both sides
- PIR of m. illiopsoas on both sides
- PIR of m. gluteus medius on the right side
- PIR of the quadriceps on both sides, with accentuation of m. vastus lateralis
- PIR of the hamstrings on both sides, with accentuation of m. biceps femoris
- Joint mobilization by Lewit: ventral mobilization of the IP joints III, IV and V on the right side.
- Control of McKenzie extension exercises (10+ repetitions)
- Control of breathing exercises with activation of m. transversus abdominis
- Control of Sensory-motoric stabilization with practicing of the "small foot" performing lunges
- Control of pelvic floor strengthening exercises (in 3 month baby position by Vojta)

Result: No blockages were found after joint play examination, except for the IP joints in both feet – they were blocked ventrally. Muscle length of the piriformis was normal; this confirms that the therapy from the last treatment was successful. The hamstring muscle length is still shortened on the right side. The hamstrings length on the left side has improved since the last therapy. Lasegue's test is positive on the right at 55 degrees. The muscle length of the illiopsoas, gluteus medius on the right side, the tensor fascia on both sides and both quadriceps had reached a normal length after the progressive use of PIR. PIR and self-PIR on these muscles will no longer be needed so as not to over stretch them. Next therapy session we can begin with education of the basic movement patterns in hip abduction and hip extension since the tight muscles in the hip area have now reached a normal length.

Self-Therapy:

- McKenzie back extensions (10 reps., every 2 hrs. – breathe out during maximal extension, hold this for a few seconds)
- Modified Self-PIR by Lewit for the hamtrings. This exercise was modified by using a towel to assist with PIR of the hamstrings – knee extension with hip flexion in the supine position (3 reps., 3 times a day – hold for 20 seconds each repetition).
- Pelvic floor strengthening exercises (in 3rd month baby position by Voijta)
- Breathing exercises (with activation of m. transversus abdominis)

Day 5: Wednesday, 23.01.2013 **Time:** 14:00

Status Praesens: The patient has achieved normal ROM both in the extremity, and improved ROM in active movements of the spine. The hamstrings on the R are still stiff and there is pain with a positive Lasegue at 55 degrees. Overall, the patient feels less pain than the previous day (VAS 3-/10). The pain has become centralized as it is not radiating into the leg anymore, unless provoked.

Goals of Today's Therapy: Continue with exercises that were prescribed on the previous visit. Continue PIR for the hamstrings and m. quadratus lumborum on both sides. Discontinue PIR for the m. tensor fascia lata, m. illiopsoas, m. quadriceps and m. gluteus medius. Begin new exercise of re-educating the altered motor patterns in the hip in both abduction and extension.

Implementation: The muscle length tests were performed again to make sure the length has not changed. Joint play in the lumbar segments, SI joint, TF, patellae and IP joints in the feet were examined. The McKenzie exercises were controlled again, as well as the breathing pattern with activation of abdominals. Basic movement patterns in hip abduction and hip extension were trained. This will be added into the therapy.

Therapy Summary:

- Soft tissue techniques of TH and L fasciae in cranial-caudal direction on both sides
- PIR of m. quadratus lumborum on both sides, (longer hold of breath on the right side)
- PIR of the hamstrings on both sides, with accentuation of m. biceps femoris
- Re-education of Basic Movement Patterns in hip abduction and hip extension
- Control of McKenzie extension exercises (10+ repetitions)
- Control of breathing exercises with activation of m. transversus abdominis
- Control of Sensory-motoric stabilization with practicing of the “small foot” performing lunges
- Control of pelvic floor strengthening exercises (in 3 month baby position by Vojta)

Result: The patient was able to perform the normal movement pattern in both extension and abduction of the hip. These patterns were altered to begin with, but after some practice the patient was able to do it correctly.

Self-Therapy:

- McKenzie back extensions (10 reps., every 2 hrs. – breathe out during maximal extension, hold this for a few seconds)
- Modified Self-PIR by Lewit for the hamtrings. This exercise was modified by using a towel to assist with PIR of the hamstrings – knee extension with hip flexion in the supine position (3 reps., 3 times a day – hold for 20 seconds each repetition).
- Pelvic floor strengthening exercises (in 3rd month baby position by Voijta)
- Breathing exercises (with activation of m. transversus abdominis).

Day 6: Thursday, 24.01.2013 **Time:** 14:00

Status Praesens: The patient reports the pain on VAS to be 2-3/10. This is a great improvement since the initial therapy session. The exercises seemed to have helped the patient quite a lot, and he says he will continue doing these at home after he is discharged.

Today is his last day in the hospital and he will continue rehabilitation as an outpatient with a therapist specialized in the McKenzie technique.

Goals of Today's Therapy: Continue with exercises that were prescribed on the previous visit. Continue to decrease pain; improve ROM; improve core stability; modify breathing pattern; improve motor patterns. Perform the Final Kinesiological Examination.

Implementation: The therapy was controlled for the last time (see therapy summary). The patient was asked to continue the self-therapy at home. The long-term plan was also discussed (see long-term therapy plan). The final kinesiological examination was performed.

Therapy Summary:

- Soft tissue techniques of TH and L fasciae in cranial-caudal direction on both sides
- PIR of m. quadratus lumborum on both sides, with longer hold of breath on the right side
- PIR of the hamstrings on both sides, with accentuation of m. biceps femoris
- Re-education of Basic Movement Patterns in hip abduction and hip extension
- Control of McKenzie extension exercises (10+ repetitions)
- Control of breathing exercises with activation of m. transversus abdominis
- Control of pelvic floor strengthening exercises (in 3 month baby position by Vojta)
- Control of Sensory-motoric stabilization with practicing of the "small foot" performing lunges
- The Final Kinesiological Examination was performed

Result: The pain in the lumbar spine has become centralized. The patient feels less pain now and it is localized only in the low back. The pain is much less severe than before. The Lasegue's test was positive at 60 degrees, but with slight pain. Some major improvements were seen: the patient is able to stand without pain; he is able walk on heels without pain; the pain radiation to the right leg has disappeared; and the ROM in extremities and the lumbar spine has greatly improved.

Self-Therapy: Continue with same exercises at home as a home-therapy. For long-term therapy (see long-term therapy plan).

3.6 Final Kinesiological Examination

Examination Proposal:

- **Aspection of posture**
    - Breathing Pattern
- **Pelvic Examination + Other tests**
    - Palpation of SIAS, SIPS
    - Overtake phenomenon
    - Scale test
    - Patrick’s test (piriformis)
    - Trendelenburg Test
- **Spine distances**
    - Shober’s distance
    - Latero-flexion
- **Gait**
    - Walking naturally
    - Walking in straight line
    - Tip-toes
    - Heels
    - Squatting walk
- **Basic movement patterns**
    - Hip extension
    - Trunk flexion
    - Hip abduction
    - Neck flexion
- **Anthropometry**

    - Anatomical leg length
    - Functional leg length
    - Circumferences of leg
- **Palpation**
- **Active ROM**
- **Passive ROM**
- **Muscle Strength Testing**
    - Abdominals
    - Gluteals
    - Quadriceps
    - Tibialis anterior
    - Peroneals
    - Gastrocnemius
    - Extensor digitorum longus
    - Extensor hallucis brevis
    - Abductor hallucis
- **Joint Play**
    - SI joint
    - L-spine intervertebral joint segments
    - TF joint
    - Patella
    - Knee joint
    - TC joint, Chopard's, IPH, Calcaneus
- **Neurological Examination**
    - Deep Tendon Reflexes
    - Deep Sensation
    - Dermatomes
- **ADL assessment**
    - Lifting, sleeping, sitting positions

Aspection:

Anterior view: The posture is still kyphotic in the Th-region, but the lordosis in the lumbar spine is to a lesser degree than it initially appeared to be. The right leg is not as abducted and externally rotated. The iliac crest remains higher on the right side, so lateral tilt of the pelvis is present. The umbilicus is still slightly deviated to the right side but the activation of the abdominals during breathing is now present. The R arm musculature appears to have more trophy than the L side. The R shoulder remains higher than the L side as well. This seems to be caused by the right handed use of the patient.

Right Lateral view: Both legs appear to be in the same frontal plane. The knees are in good alignment – no semi-flexion or hyperextension. The lordosis of the lumbar spine is less pronounced than it was initially and the patient does not lean forward on his toes as much as before – during standing.

Left Lateral view: Both legs seem to be in good alignment. The knee semi-flexion on the right side is no longer present. The kyphosis in the TH-region is very slight. In the lumbar region the lordosis was reduced.

Posterior view: The patient stands with the feet shoulder width apart. It appears that the full body weight-bearing is placed slightly more towards the L side of the body. The legs appear to be in the same frontal plane. The R leg is only slightly abducted with some external rotation, but is not the same as it was when he first came in. It is evident that the R iliac crest is higher than the L: this is the most prominent feature in the dysfunction when the patient is viewed as a whole.

Active Movements of the Spine:

Forward Bend: The patient can bend forward without pain. The whole range of movement has increased by 4 cm. The pelvis remains more in line with the rest of the body, compared to the initial bend, when it deviated out of the frontal plane. The lumbar spine seems to have some range of movement compared to it initially having none. The patient cannot reach the floor, but the hamstrings are less restricted and the range is further to the floor than it initially was.

Side-Bending to the right: The legs are kept shoulder width apart. The patient is able to side bend to the right without pain. The lumbar spine has definite movement now, as the patient can bend much further than he initially could. The thoracic spine has a fluent curve. The cervical spine is laterally flexed, with the distance between the ear and shoulder being 4 cm. The range of mobility of the spine had improved overall, such that there was increased movement in lumbar and thoracic spines and decreased compensation of movement in the cervical spine by 1cm.

Side-Bending to the left: The patient is able to bend to the left side without pain. The left leg does not abduct as it did before. Both legs are in good alignment. The lumbar spine is more mobile than before. The range of motion still seems to be slightly increased when bending to this side, but there is definite improvement in movement to both sides concerning the lumbar spine. The cervical spine is still hyper-flexed but to a lesser degree, with the ear-to-shoulder distance being 3 cm from touching the right shoulder. This is 1 cm decrease in compensation of movement in the cervical spine – overall a positive result.

Backward Bend: The patient can perform this movement without pain; which is definite improvement from the initial backward bend where there was pain located in the low back. The semi-flexion of the knees is no longer present. The abdomen does not protrude as much as it did before.

Breathing Pattern (supine): The breathing pattern is much more regular now; the patient has activation of the abdominals (particularly the transversus abdominis muscle). You can see that the breathing does not begin in the chest but it begins in the abdomen. There is abduction and elevation of the ribs and thorax following the abdominal movement which is a positive result.

Pelvis Examination:

Palpation of ASIS/PSIS:

Anterior **–** the SIAS is higher on the patient's right side

Posterior **–** the SIPS is higher on the patient's right side

Lateral **–** the SIPS and SIAS on both lateral sides anteriorly and posteriorly are level with each other.

- There is still the presence of lateral pelvic tilt, with the right side being higher.
- There is no torsion of the pelvis.
- The overall anterior tilt is to a lesser degree than it was on the initial examination but there is still higher iliac crest on the right side.

Other Tests: (Table 14.)

Spine Distances: (Table 15.)

Gait:

Walking naturally: No pain is present during the swing phase of the R leg, as was initially reported by the patient. The body-weight bearing is slightly more towards the left leg but this could be caused by the anatomical leg length difference and the tendency to lean to the shorter side. No limping is present. The pelvis on the R side slightly rotates forward. The umbilicus is deviated to the R side. The R leg slightly circumducts during the swing phase.

Walking in straight-line: The patient is able to perform this test without problems in balance or pain. There is a slight rotation of the pelvis on the right side anteriorly. There is a tendency to lean to the left.

Walking on Tip-toes: The patient is able to perform this test without any pain or difficulty.

Walking on Heels: The patient is able to perform this test. This is a major improvement, because initially he was not able to perform this test due to pain.

Squatting walk: The patient is able to perform this test without pain, but with extremely wide base of the feet.

Basic Movement patterns:

Hip Abduction – The movement pattern in both legs was normalized. The patient is able to initiate movement with the m. gluteus medius, instead of the m. illiopsoas. The hip is no longer in flexion and the hip was not elevated during this pattern.

Hip Extension – The left leg has a correct pattern; the right leg pattern is in the correct form, and there is no pain on this side.

Trunk Flexion – The patient substituted still with the hip flexors. The movement was quickly performed, with a rocking motion of the torso (like a block) during flexion and shaking of the weak abdominals. When asked to perform the movement slowly, you could see that the patient was able to activate these muscles. The patient was not able to perform complete trunk flexion. This pattern remained altered because of abdominal weakness. During the second test, with activation of the hamstrings into plantar flexion with pressure against the feet, you could see the initiation of activation of the abdominals rather than the m. illiopsoas. This is a positive sign, because it means that the movement is not fixed in the CNS, but altered.

Neck Flexion – There were no differences in this exam. Upon initiation of movement there was anteflexion of the neck, with initiation of the sternocleidomastoid muscle. This pattern was altered due to weakness of deep neck flexors and overuse of m. sternocleidomastoid. It was not a fixed pattern because when told how to do it properly, there was activation of the deep flexors. This pattern should be normalized as a treatment in the long term.

Anthropometry: (Table 16.)

Examination of Skin and Fascia: (Table 17.)

Palpation: (Table 18.)

Muscle Length: (Table 19.)

Active ROM: (Table 20.)

Passive ROM: (Table 21.)

Muscle Strength: (Table 22.)

Joint Play (by Lewit): (Table 23.)

Neurological Findings:

Deep Tendon Reflexes:

- ***Achilles***
  - **Right:** normoreflexia, without reinforcement, grade 1+
  - **Left:** normoreflexia, grade 2+
- ***Plantar Flexors***
  - **Right:** normoreflexia, without reinforcement, grade 1+
  - **Left:** normoreflexia, grade 2+
- ***Patellar***
  - **Right:** normoreflexia, grade 2+
  - **Left:** normoreflexia, grade 2+

Deep Sensation:

- **Joint Position Sense** (arthresthesia)**:** negative

- **Vibratory sense** (pallesthesia)**:** negative
- **Perception of Movement** (kinesthesia)**:** negative

Sensation in Dermatomes:

Result: all were felt with the same intensity on both legs.

- **L1/L2**
- **L3/L4**
- **L5/S1**
- **S1/S2**

Lasegue Test:

Right leg: Positive at 60 degrees, with slight pain

Left leg: negative

Reverse Lasegue Test:

Right leg: negative

Left leg: negative

Final Kinesiological Examination Conclusion

- Forward-bend: This movement was increased by 2cm.
- Side-bending: This movement was improved, such that there was increased movement in lumbar and thoracic spines and decreased compensation of movement in the cervical spine by 1cm. on both sides.
- The breathing pattern improved: The patient activates the *m. transversus abdominis* and breathes beginning with abdomen, following with expansion of ribs and elevation of thorax.
- Backward bend: This movement is no longer painful for the patient. The patient is able to bend backward without having to bend the knees to such a degree as he initially had done. The lumbar spine is mobile in this movement. The abdomen does not protrude to the degree that it initially did.

- Pelvic examination: – The ASIS and PSIS and anteriorly tilted on both sides, but less than on initial evaluation. The right iliac crest is higher than the left.
- The anthropometric measurements remained the same.
- Patricks test for m. piriformis length was negative on both sides.
- Shober distance increased by 2 cm, is now within the “normal” range.
- Latero-flexion: side bending to the right increased by 4 cm.
- Walking on heels: the patient can now perform without pain.
- No blockages were found in tibio-fibular in ventral direction; no blockages in patellae.
- No blockages were found in IP joints of both feet in dorsal-ventral direction
- There was improved mobility of skin and fasciae in both lumbar and thoracic surfaces in all directions; disappearance of HAZ along paravertebral area; skin mobility was restored in the right lower calf of L5 dermatome.
- Achilles and Plantar tendon reflexes were able to be elicited without use of reinforcement: both reflexes were normoreflexia: 1+; trace grade.
- Lasegue’s tested positive in the right leg at 60 degrees, with slight pain – this is 15 degrees improvement in ROM since the initial examination.

3.7 Evaluation of the Effect of the Therapy

On the first day, (Thursday 17.01) only bed rest was prescribed. The pain was 6-8/10 with pain shooting into the L5 distribution down to the great toe. He was given an infusion and painkillers. On the second day (Friday 18.01), the initial kinesiological exam was performed. The patient reported pain being 5-8/10. He felt the most pain during walking and standing after short periods. The relief position during these episodes was squatting or stooping. Instructions were given on proper positioning in sitting, lifting and lying. It was recommended NOT to perform any flexion of the spine, such as squatting or stooping; but rather to lie on the belly in prone positioning while sleeping and with the forearms propped up in prone (as in reading a book) during day rest; also to eliminate long sitting durations and to avoid lying on the back with the knees and hips flexed or any sort of fetal position. (This recommendation was given according to the therapy procedure by McKenzie, where the patient should avoid all flexion movements as this would contraindicate the aim of therapy to move the vertebrae into extension) (McKenzie, 2011) From this day, the patient was administered physical therapy and a self-therapy treatment plan. The patient was assisted in the modeling of the “small foot” for sensory-motoric stabilization. He practiced this first in sitting, after he progressed to standing. Release of the TrP in the upper thoracic region on the right side was achieved by counter-pressure with breathing. After PIR, the patient felt relief in the taut muscles, and a notable difference was seen after PIR of the m. piriformis on the left side. The goal was to continue the self-therapy over the weekend.

On the third day (Monday, 21.01) the patient was seen again. The patient reported that he performed the self-therapy exercises. The pain on this day was 4/10. The patient had one complaint about feeling a “pulling sensation” on the right side of the trunk when he performed the McKenzie exercises. These exercises were then corrected. Added “overpressure” was administered with the McKenzie extensions to the lumbosacral region of the spine. The patient practiced stepping with use of the “small foot”. Corrections of the breathing exercises were also administered. By this day, bigger improvements were seen: improvement of forward bend by 2cm; improvement in side-bending to the right by 4cm; increased mobility of the skin and fascia along the spine in the lumbar and thoracic regions. The blockages in both patellae in caudal directions and the tibiofibular joint on the right side in ventral direction had disappeared. The normal length for the m. piriformis was successfully reached, and the PIR was no longer administered for this muscle.

By the fourth day (Tuesday 22.01) the patient reports “feeling better than yesterday” and continuing with the McKenzie exercises and self-therapy. The pain is 3-4/10 today. The goals on this day were to continue with exercises and continue to decrease pain, improve ROM, strengthen muscles and modify breathing pattern. Upon muscle length examination, the hamstrings had improved on the left side, but on the right side they were still restricted with pain. Lasegue’s test was positive to 55 degrees. The quadratus lumborum also remained taut, but less taut than on the initial exam. The following muscles had reached a normal length after progressive use of PIR: m. illiopsoas on either side, gluteus medius on the right side, tensor fascia latae on either side and quadriceps. Since normal ROM has been met (ecept the remaining right hamstrings and quadratus lumborum on both sides) It was at this point suitable to administer the Re-education of movement patterns. The patient progressed to lunges with use of the "small foot" as sensory-motoric training.

On the fifth day (Wednesday, 23.01) the muscle length was checked again. The PIR was discontinued from therapy for the following muscles: m. tensor fascia late, m. illiopsoas, m. quadriceps and m. gluteus medius on the right side. The re-education of movement patterns in both hip abduction and hip extension were administered. The breathing pattern was also controlled. The activation of abdominal muscles was observed. The McKenzie exercises were controlled. Pelvic floor exercises were controlled. Movement patterns of hip abduction and extension were added to the therapy. The patient was taught normal patterns, and after a few tries he was able to perform the correct patterns in both movements. On (Thursday 24.01) the final kinesiological exam was performed. Upon the neurological testing, the Achilles and Plantar deep tendon reflexes were able to be elicited (both were normoreflexia, without reinforcement, but both were trace grade 1+). The lasegue's test was positive at the point of 60 degrees with only slight pain. The use of "small foot" in lunges was controlled again. The therapy and exercises were controlled for the last time, and the patient was asked to continue the self-therapy at home. He was also recommended to follow up with out-patient therapy with a therapist specialized in McKenzie. The long-term plan was discussed. The patient reported the pain to be 2-3/10 on the final day of the visit.

Summary of the Effect of the Therapy:

- Pain decreased (it was centralized) it went from 6-8/10 to 2-3/10.
- The fascias and skin mobility improved in the low back
- Achilles and Plantar reflexes were elicited on the final examination
- L5 Radiculopathy sensorimotoric state diminished as the pain was centralized into the lumbar spine.
- Lumbar spine ROM improvement in forward bend and in side bending

- Overall improved ROM
- Improvement in breathing pattern (activation of abdominals)
- Improvement in joint mobility (blockages were released and did not return)
- Lasegue's test was positive at 60 degrees with slight pain; this is a 20 degree increase in the ROM without presence of pain.

(Table 24.) Subjective and Objective Comparison Before and After the Therapy

The main goal of the therapy was to centralize the pain to the lumbar spine. Although the lasegue test was still positive, there was obvious centralization as the his test result went from pain at 40 degrees to 65 degrees. This effect was achieved, as patients pain was dramatically reduced after the therapy. Other goals included: improvement of range of motion in restricted muscles; elimination of TrP in the upper thoracic region; influencing the sensory-motoric stability; improving joint mobility; improving mobility of fascia; improving mobility of the lumbar spine; influencing proper breathing pattern; activating the pelvic floor and abdominals. These improvements were seen after just seven days. The prognosis looks good for the patient; I would recommend continuing the therapy that was given as a self-treatment to do at home, and continue long-term therapy with a PT specialized in McKenzie.

Other Suggested Therapy:

- PNF upper trunk and lower trunk diagonals for strengthening abdominal muscles
- PNF pelvic diagonal for strengthening of abdominal obliques
- Exercises for strengthening the upper back
- Exercises for strengthening the deep neck flexors
- Remedial exercises for the abdominal obliques (according to Kendall)
- Physical therapy modalities – heat therapy, Electrogymnastics (TENS, Trabert)
- Further Scoliosis prevention
- Anatomical leg length shoe insets

4 Conclusion

The method of treatment was administered in different structured phases:

- ***Phase One***: Treatment of muscle imbalance in relation to Janda theory – you must treat the tight muscles first, then relax the weak muscles. Improving the ROM, eliminating TrPs, and releasing the taut skin and fascia created a good starting base for the re-education of movement patterns. (Therapies used: myofacial release techniques, PIR for relaxation of the taut muscles, joint mobilization to promote good mobility in the joints)
    - Pelvic floor exercises and Breathing pattern training – (activation of the diaphragm, m. transversus abdominis, m. multifidi, pelvic floor). The breathing pattern is a movement pattern in itself but should be taught to the patient at the beginning because these are the deep core muscles that can promote other muscle chains to work in a more fluent manner. Also, there are no muscle imbalance to treat here (ie. taut and weak muscle chains) usually just weakness, so activation can be administered in the early stages of treatment.
- ***Phase Two***: Re-educating the movement patterns – influencing the activation of weak muscles that were previously neglected and promote the usage of these muscles in their primary movements. Proprioceptive techniques can be used to promote orientation of joint and muscle movement to encourage the basic concept of motor learning (Therapies that can be used: re-education of basic movement patterns, sensory-motoric training of the small foot and usage of the wobble board etc., facilitation of weak muscles by modalities or manual stimulation)
- ***Phase Three:*** Strengthening techniques to promote stability. Once the CNS has recognized that a specific muscle should be activated (the brain knows a muscle, not a movement!) then we can apply strengthening techniques to encourage stability and support to the trunk (PNF facilitating techniques, exercise and maintenance of muscle strength in the new appropriate movement pattern)

- ***Result and prognosis:*** the patient will have new movement patterns that will be encoded in the CNS; good muscle balance with full range of movement; and strong muscles that will prevent re-injury and promote stability and relieve pain.

The time was limited to five days of therapy with my patient (+ weekend self-therapy). We achieved the goals spoken about in phase one and phase two – the same goals that correspond with the hypothesis. The patient was dismissed from the hospital on day seven.

The achievements of goals of the therapy were with good outcome. The following results of the therapy were: decrease of pain and centralization of pain to the lumbar spine; improvement of ROM in both the extremities and lumbar spine; improvement of mobility of restricted skin, fascia and muscle; achieving the ideal position of the "small foot" and the basic sensory-motor stability in stepping and lunging; influencing the breathing pattern with activation of deep core muscles – strengthening of these muscles; mobilizing joints and eliminating the blockages; re-educating the basic movement patterns in hip abduction and hip extension; and influencing reflex activity in the Achilles and Plantar deep tendons. Phase three will be the promotion of muscle strength and stability in the spine, which the patient will continue as an out-patient in rehabilitation at UVN. He will also continue with the McKenzie exercises.

An interesting feature that I discovered during the initial examination of my patient was an anatomical leg length discrepancy with the leg being 2 cm longer on the right side. This to me seems to be a possible underlying factor to the initial cause of the disc herniation and low back pain. The leg length difference can cause lateral tilt of the pelvis, which the patient also had, and potentially result in the more serious matter of scoliosis to the spine. Upon examination, there was a slight deviation of the lumbar spine from the thoracic spine in a very slight C-curve form which could possibly be the beginning of scoliosis. These findings change the prognosis of the initial diagnosis because now the patient must care about the leg-length difference. Disrupted and unorganized movement patterns, musculoskeletal imbalance and pain all go hand-in-hand with structural abnormalities, and all three of these findings were positive in my patient.

The musculoskeletal imbalance that were found on initial examination involved weakness of the abdominal muscles (trunk flexors) and shortness of back muscles (trunk extensors) – incoordination of antagonist-agonist activity. This finding corresponds to the study carried out by Liebenson et. al. in which a group of LBP patients were discovered to have incoordination of agonist and antagonist activation. (Liebenson, 2006) The instability of the trunk muscles suggests that the patient is predisposed to spinal re-injury. Therefore, it is a crucial element in the therapy plan that the patient requires strengthening of the abdominals and deep core stabilizers including the muscles of the pelvic floor. In the patient's acute stage, it was not possible to perform abdominal strengthening such as PNF diagonals in trunk or pelvis, or remedial exercises with anteversion of the pelvis, as these involve flexion of the lumbar spine and would be contraindicative to the application of the McKenzie method; hence, breathing exercises with activation of the transverse abdominis muscle and rectus abdominis (during exhalation) was the most simple and pain-free choice at this time. Although, I would recommend that additional therapies be provided after the McKenzie therapy is discontinued.

Another option for therapy is PNF strengthening techniques (particularly for the m. rectus abdominis on the right side, and the abdominal obliques on both sides) – trunk and pelvic diagonals. Also PNF relaxation techniques could have been used. Although proven to be effective, I found that using the McKenzie technique was somewhat isolating in the sense that it could not be combined with other therapies that would involve flexion of the spine (a contraindicative position to McKenzie extension exercises) because of the strict adherence to continuous extension of the lumbar spine, which contradicts a majority of positions in other potentially useful therapies.

The possible development of scoliosis should be paid close attention to, and the necessary prevention therapy should be administered. The best prevention for the development of scoliosis would be to continue with strengthening exercises for the core muscles. For the leg-length difference I would recommend a shoe insert for the shorter leg to level out the pelvis. I would also continue to train sensory-motoric stability as a therapy and prevention. I would continue with training basic movement patterns for the muscle chains in the abdomen and pelvis.

Another interesting factor is what I discovered upon initial neurological examination: the Achilles and plantar tendon reflexes in the right leg were unresponsive. After five days of therapy these reflexes had returned. The Achilles and plantar reflexes correspond to the spinal segments L5 and S1. There is a possibility more nerve roots became involved (as a result of compression) after the initial diagnosis by the physician.

The difference of functional measuring from the umbilicus to the malleolus medialis was found to be longer on the right side. There was obvious deviation of the umbilicus away from the *linea alba* toward the left side. The muscle strength of the m. rectus abdominis, m. internal and external obliques on the right side had less tonicity upon palpation examination and the strength was weaker on this side of the abdominal as well, as the navel was drawn towards the left side during basic movement pattern testing of trunk flexion. *During exhalation and abdominal exercises, the navel is drawn towards the strongest segment of m. rectus abdominis* (Janda, 2004) *If there is asymmetry between the muscle chains consisting of m. external obliques and internal obliques, the navel is drawn to the stronger side.* (Janda, 2004). My proposition is that these factors could be in relation to inguinal hernia at age 6 which was also localized on the right side. *Direct inguinal hernias are caused by acquired weakness of the transversalis fascia (aponeurtic membrane lying over the transversus abdominis) and hence are located medial to the inferior epigastric vessels.* If there was acquired weakness on the right side since before the age of six, this may have never been properly treated (by strengthening of deep abdominals) and thus, an inclusive factor in the cause of right-sided prolapse of the lumbar intervertebral disc.

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6 Supplements

Desiccation	Loss of water inside the disc
Disc bulge	Circumferential enlargement of the disc contour in a symmetric fashion
Protrusion	A bulging disc that is eccentric to one side but < 3 mm beyond vertebral margin
Herniation	Disc protrusion that extends > 3 mm beyond the vertebral margin
Extruded disc	Extension of nucleus pulposus through the annulus fibrosis into the epidural space
Free fragment or *Sequestration*	Epidural fragment of a disc that is no longer attached to the parent disc

(Table 1.) Terminology Related to Degeneration of a Disc

Root	Pain	Sensory Loss	Weakness	Reflex Loss
L1	Inguinal region	Inguinal region	Rarely hip flexion	none
L2, L3, L4	Back, radiating to anterior thigh and medial lower leg	Anterior thigh, medial lower leg	Hip flexion, hip adduction, knee extension	Patellar tendon
L5	Back, radiating to buttock, lateral thigh, lateral calf, dorsum of foot, great toe	Lateral calf, dorsum of foot, web space between 1st and 2nd toe	Hip abduction, knee flexion, foot dorsiflexion, toe extension and flexion, foot inversion	Semitendinosus, semimembranosus, (internal hamstrings) tendon

			and eversion	
S1	Back, radiating to buttock, postero-lateral thigh, posterior calf, lateral or plantar foot	Posterior calf, lateral or plantar aspect of foot	Hip extension, knee flexion, plantar flexion of the foot	Achilles tendon
S2, S3, S4	Sacral or buttock pain, radiating to posterior aspect of leg or the perineum	Medial buttock, perineal, and peri-anal regions	Weakness may be minimal with urinary and bowel incontinence and sexual dysfunction	Bulbocavernosus, anal wink reflex

(Table 2.) Clinical Picture of Nerve Root Syndromes in the Lumbar Spine (Millette, 1997)

Name of Test:	**Result:**
Overtake Phenomenon	Distortion is present on the right side; No blockage
Patrick's Test (to test length of m. piriformis)	Right: Normal (45 degrees of IR) Left: Shortened (positive test)
Trendelenburg's Sign	Standing on R leg: negative Standing on L leg: negative

(Table 3.) Other Tests

Name of Test:	**Normal Finding:**	**Patient's Result:**
Shober's distance	4-6 cm	3 cm

Latero-Flexion	20-25 cm	Bending to the R: 14 cm Bending to the L: 22 cm

(Table 4.) Spine Distances

Part measured	**Right**	**Left**
Anatomical leg length (from trochanter major to malleolus lateralis)	92 cm	90 cm
Functional leg length (from SIAS to malleolus medialis)	96 cm	94 cm
Functional leg length (from umbilicus to malleolus medialis)	103 cm	104 cm
Circumference for Quadriceps	53 cm	54 cm
Circumference for m. vastus medialis	50 cm	51 cm
Circumference of calf	36 cm	38 cm

(Table 5.) Anthopometry

Part Examined	**HAZ/ Restricted direction**
Kibler's Fold over whole back	Restriction of fascia in lumbar-sacral area, HAZ reaction – redness on skin and tingling to the low back
Lumbar skin/ fascia – all directions	Skin was restricted in cranial-caudal direction; Fascia was restricted in cranial-caudal direction
Thoracic skin/ fascia – all directions	Skin was mobile in all directions; Fascia was restricted in cranial-caudal direction
Skin/ fascia of lower extremities	Skin restricted in lateral direction on the right lower calf in dermatome L5

(Table 6.) Examination of Skin and Fascia

Muscle	Right	Left
Erector spinae	TrPs, hypertone	hypertone
Rectus Abdominis	hypotone	eutone
Quadratus lumborum	hypertone	hypertone
Gluteus medius	hypertone	eutone
Piriformis	eutone	hypertone
Hamstrings	hypertone (biceps femoris)	hypertone (biceps femoris)
Gastrocnemius (both heads)	hypotone (medial head)	eutone
Illiacus	hypertone	hypertone
Psoas	hypertone	hypertone
Vastus medialis	eutone	eutone
Rectus Femoris	hypertone	hypertone
Vastus lateralis	hypertone	hypertone
Adductors	eutone	eutone
Tensor fascia lata	hypertone	hypertone
Tibialis anterior	eutone	eutone

(Table 7.) Palpation

Muscle tested	Right	Left
Hamstrings	shortened, with pain to 45° F	shortened
Illiopsoas	very shortened	shortened
Quadriceps	very shortened, more lateral	shortened
Tensor fascia latae	very shortened	very shortened
Quadratus lumborum	very shortened, more on this side	very shortened
Piriformis	normal	very shortened

(Table 8.) Muscle Length

Part/ Movement Tested	Norm. acc.	Right	Left

	to Kendall		
Hip Flexion with bent knee	125	125	125
Hip Flexion with extended knee	80	To 45° without pain, above 45° with increasing pain	65
Hip Internal Rotation	45	35	40
Hip External Rotation	45	45	45
Hip Abduction	45	45 (with pain)	45
Hip Adduction	10	10	10
Hip Extension	10	10	10
Knee Flexion	140	130	130
Knee Extension	0	-5	0
Ankle Dorsiflexion	10-15	10	10
Ankle Plantarflexion	45	50	50
Ankle Inversion	40	40	40
Ankle Eversion	20	20	20

(Table 9.) Active ROM

Part/ Movement Tested	**Norm. acc. To Kendall**	**Right**	**Left**
Hip Flexion with bent knee	125	125	125
Hip Flexion with extended knee	80	45 (to the point of pain)	70
Hip Internal Rotation	45	40 (soft barrier)	40 (soft barrier)
Hip External Rotation	45	45	45
Hip Abduction	45	45 (with pain during whole range)	45
Hip Adduction	10	10	10
Hip Extension	10	10	10
Knee Flexion	140	135	135

Knee Extension	0	-5 (soft barrier)	0
Ankle Dorsiflexion	10-15	10	10
Ankle Plantarflexion	45	50	50
Ankle Inversion	40	40	40
Ankle Eversion	20	20	20

(Table 10.) Passive ROM

Muscle Graded	**Right**	**Left**
Lower abdominals	3 (holds test position, no added pressure)	
Oblique trunk flexors	3 (holds test position, no added pressure)	
Gluteus maximus	5+	5+
Gluteus medius	5	5
Quadriceps	5	5
Tibialis anterior	4	4
Peroneals	4	4
Extensor hallucis brevis	4-	4-
Extensor digitorum longus	4	4
Abductor hallucis	2-	2-
Gastrocnemius	4	5+

(Table 11.) Muscle Strength

Joint/ direction Examined	**Right**	**Left**
Lumbar vertebral segments – ventral	No blockage	No blockage
SI (upper part) springing (prone) - ventral	No blockage	No blockage
SI (lower part) springing (sidelying) - ventral	No blockage	No blockage
Tibio-fibular – ventral	Restricted	No blockage
Tibio-fibular – dorsal	No blockage	No blockage

Patella – all directions	Restricted caudally	Restricted caudally
Knee – latero-lateral	No blockage	No blockage
Knee – dorsal-ventral	No blockage	No blockage
Talo-crural – dorsal-ventral	No blockage	No blockage
Talo-crural – latero-lateral	No blockage	No blockage
Chopard's joints – dorsal-ventral	No blockage	No blockage
Metatarsals – dorsal-ventral	No blockage	No blockage
Metatarsals – latero-lateral	No blockage	No blockage
Calcaneus – dorsal-ventral	No blockage	No blockage
Calcaneus – latero-lateral	No blockage	No blockage
IP joints – all directions	Blockages in ventral direction in III, IV, V IPJ both sides	

(Table 12.) Joint Play (by Lewit)

Pain:	During heel-walking, hyper flexion of the lumbar spine, hip extension and hip abduction on the right side; during walking and standing (VAS): 5-8/10.
Skin:	Restricted in caudal-cranial direction in lumbar region on both sides of the spine. Restricted in dermatome L5 in the right lower extremity in lateral direction.
Fascia:	Restricted in caudal-cranial direction in lumbar and thoracic region with TrPs in upper thoracic region on the right side.
Muscle Shortness:	M. illiopsoas (both sides, more on right); hamstrings, esp. m. biceps femoris (more on right side); quadriceps, esp. m. vastus lateralis (both sides), m. tensor fascia latae (both sides); m. gluteus medius (on the right side); m. piriformis (on the left side)
Muscle Weakness:	Lower abdominals, oblique trunk flexors, m. transversus abdominis.
Joint Blockage:	The patella was restricted in caudal direction on both sides; tibio-

	fibular joint restricted in ventral direction on the right side. III, IV, and V. IP joints restricted in ventral direction in both feet.
Neurological disturbance:	Positive Lasegue's test to the point of 45 degrees on the right side. Achilles and plantar reflexes, hyporeflexia, grade 0.

(Table 13.) Conclusion Summary for the Purpose of Therapeutic Intervention

Name of Test:	Result:
Overtake Phenomenon	No blockage; positive on the right side for muscular distortion but very slight.
Patrick's Test (to test length of m. piriformis)	Right: negative Left: negative
Trendelenburg's Sign	Standing on R leg: negative Standing on L leg: negative

(Table 14.) Other Tests

Name of Test:	Normal Finding:	Patient's Result:
Shober's distance	4-6 cm	5 cm
Latero-Flexion	20-25 cm	Bending to the R: 18 cm Bending to the L: 22 cm

(Table 15.) Spine Distances

Part measured	Right	Left
Anatomical leg length (from trochanter major to malleolus lateralis)	92 cm	90 cm
Functional leg length (from SIAS to malleolus medialis)	96 cm	94 cm

Functional leg length (from umbilicus to malleolus medialis)	103 cm	104 cm
Circumference for Quadriceps	53 cm	54 cm
Circumference for the m. vastus medialis	50 cm	51 cm
Circumference of calf	36 cm	38 cm

(Table 16.) Anthropometry

Part Examined	HAZ/ Restricted direction
Kibler's Fold over whole back	There was a big improvement in the mobility of both the skin and fascia during Kibler's fold in the lumbar region. The HAZ has also disappeared.
Lumbar skin/ fascia – all directions	The skin and fascia mobility was restored in all directions
Thoracic skin/ fascia – all directions	Skin and fascia mobility was restored in all directions
Skin/ fascia of lower extremities	The skin was no longer restricted in the lateral direction in the right lower calf in the dermatome L5.

(Table 17.) Examination of Skin and Fascia

Muscle	Right	Left
Erector spinae	eutone	eutone
Rectus Abdominis	hypotone	eutone
Quadratus lumborum	eutone	eutone
Gluteus medius	eutone	eutone
Piriformis	eutone	eutone
Hamstrings	slight hypertone	eutone
Gastrocnemius (both heads)	hypotone (medial head)	eutone

Illiacus	slight hypertone	slight hypertone
Psoas	slight hypertone	slight hypertone
Vastus medialis	eutone	eutone
Rectus Femoris	eutone	eutone
Vastus lateralis	eutone	eutone
Adductors	eutone	eutone
Tensor fascia lata	eutone	eutone
Tibialis anterior	eutone	eutone

(Table 18.) Palpation

Muscle tested	**Right**	**Left**
Hamstrings	pain to 60° F	normal
Illiopsoas	normal	normal
Quadriceps	normal	normal
Tensor fascia latae	normal	normal
Quadratus lumborum	slightly restricted	normal
Piriformis	normal	normal

(Table 19.) Muscle Length

Part/ Movement Tested	**Norm. acc. to Kendall**	**Right**	**Left**
Hip Flexion with bent knee	125	125	125
Hip Flexion with extended knee	80	To 60° without pain, pain increasing from 60°	80
Hip Internal Rotation	45	45	45
Hip External Rotation	45	45	45
Hip Abduction	45	45 (no pain)	45
Hip Adduction	10	10	10

Hip Extension	10	10	10
Knee Flexion	140	140	140
Knee Extension	0	0	0
Ankle Dorsiflexion	10-15	10	10
Ankle Plantarflexion	45	50	50
Ankle Inversion	40	40	40
Ankle Eversion	20	20	20

(Table 20.) Active ROM

Part/ Movement Tested	Norm. acc. To Kendall	Right	Left
Hip Flexion with bent knee	125	125	125
Hip Flexion with extended knee	80	To 60° without pain, pain increasing from 60°	80
Hip Internal Rotation	45	45	45
Hip External Rotation	45	45	45
Hip Abduction	45	45 (no pain)	45
Hip Adduction	10	10	10
Hip Extension	10	10	10
Knee Flexion	140	140	140
Knee Extension	0	0	0
Ankle Dorsiflexion	10-15	10	10
Ankle Plantarflexion	45	50	50
Ankle Inversion	40	40	40
Ankle Eversion	20	20	20

(Table 21.) Passive ROM

Muscle Graded	Right	Left

Lower abdominals	3+	
Oblique trunk flexors	3+	
Gluteus maximus	5+	5+
Gluteus medius	5	5
Quadriceps	5	5
Tibialis anterior	4	4
Peroneals	4	4
Extensor hallucis brevis	4-	4-
Extensor digitorum longus	4	4
Abductor hallucis	2-	2-
Gastrocnemius	4	5+

(Table 22.) Muscle Strength

Joint/ direction Examined	Right	Left
Lumbar vertebral segments – ventral	No blockage	No blockage
SI (upper part) springing (prone) - ventral	No blockage	No blockage
SI (lower part) springing (sidelying) - ventral	No blockage	No blockage
Tibio-fibular – ventral	No blockage	No blockage
Tibio-fibular – dorsal	No blockage	No blockage
Patella – all directions	No blockage	No blockage
Knee – latero-lateral	No blockage	No blockage
Knee – dorsal-ventral	No blockage	No blockage
Talo-crural – dorsal-ventral	No blockage	No blockage
Talo-crural – latero-lateral	No blockage	No blockage
Chopard's joints – dorsal-ventral	No blockage	No blockage
Metatarsals – dorsal-ventral	No blockage	No blockage
Metatarsals – latero-lateral	No blockage	No blockage
Calcaneus – dorsal-ventral	No blockage	No blockage

Calcaneus – latero-lateral	No blockage	No blockage
IP joints – all directions	No Blockages	

(Table 23.) Joint Play (by Lewit)

Affected Part:	**Before Therapy:**	**Result After Therapy:**
Pain (subjective complaint):	(VAS) 6-8/10	(VAS) 2-3/10
Painful movements (subjective complaint):	• Pain during walking • Pain during standing • Pain during extension of the spine • Pain when lying on the L side • Pain during heel-walking • Pain during Lasegue's test at 45 degrees flexion (R leg) • Pain during ABD of the hip (R leg) • Pain during hyper-flexion of the lumbar spine	• Slight pain only after walking a long distance • No pain in standing • No pain during extension of the spine • Only slight pain when lying on the L side • No pain during heel-walking • Lasegue's test positive at 60 degrees, with slight pain. • No pain in hip ABD • Some pain during hyper-flexion but not as severe
Shober's Distance of the Spine	• 3 cm	• 5 cm
Latero-flexion Distance of the Spine	• Bending to the R: 14 cm • Bending to the L: 22 cm	• Bending to the R:18cm • Bending to the L: 22 cm
Breathing Pattern	• Upper breathing pattern - without activation of abdomen (m. transversus abdominis weakness)	• Breathing with activation of abdominis transversus, and diaphragm

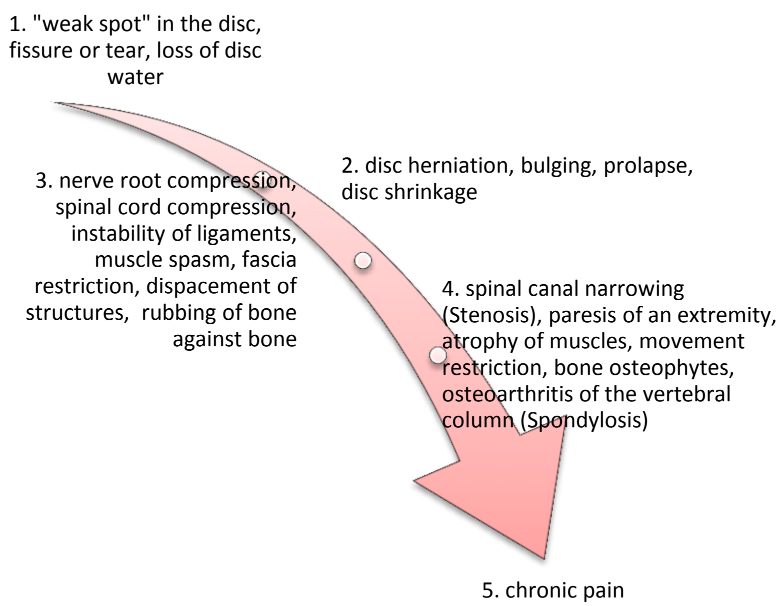
Skin:	• Restricted in caudal-cranial direction in lumbar region • Restricted in dermatome L5 region in the right lower extremity in lateral direction • HAZ with marked redness, tingling into low back along paravertebral region	• Mobile in all directions in lumbar region • Mobile in L5 region in the right lower extremity in all directions • Reduced redness, no referred pain
Fascia:	• Restricted in caudal-cranial direction in lumbar and thoracic region • TrPs in upper thoracic region on the right side	• Mobile in all directions in lumbar and thoracic regions • TrP eliminated in upper Th-region on the right side
Individual Muscle Length	• Hamstrings: shortened with pain at 45° F in the right side; shortness on the left side • Illiopsoas: very shortened on the right; shortened on the left • Quadriceps: very shortened on the right, more lateral; shortened on the left • Tensor fascia lata: very shortened on both sides • Quadratus lumborum:	• Hamstrings: shortened with slight pain at 60 degrees in the right leg; normal range on the left • Illiopsoas: normal length on both sides • Quadriceps: normal length on both sides • Tensor fascia lata: normal length on both sides • Quadratus lumborum: normal length on the left, slightly restricted

	very shortened on both sides, slightly more on the right • Piriformis: normal on the right; very shortened on the left	on the right side • Piriformis: normal length on both sides
Active ROM:	• (Right hip): R 45-0-35 • (Left hip): R 45-0-40 • (Right hip): S 10-0-40 w/ pain in flexion • (Left hip): S 10-0-65 • (Right knee): S -5-0-130 • (Left knee): S 0-0-130 • (Right hip): F 45 w/ pain-0-10 • (Right ankle): S 10-0-50 • (Left ankle): S 10-0-50	• (Right hip): R 45-0-45 • (Left hip): R 45-0-45 • (Right hip): S 10-0-60 with slight pain in flexion • (Left hip): S 10-0-80 • (Right knee): S -5-0-130 • (Left knee): S 0-0-130 • (Right hip): F 45-0-10 • (Right ankle): S 10-0-50 • (Left ankle): S 10-0-50
Passive ROM:	• (Right hip): R 45-0-40 w/ soft barrier • (Left hip): R 45-0-40 w/ soft barrier • (Right hip): S 10-0-40 w/ pain in flexion • (Left hip): S 10-0-70 w/ soft barrier • (Right knee): S -5 w/ soft barrier-0-135 • (Left knee): S 0-0-135	• (Right hip): R 45-0-45 • (Left hip): R 45-0-45 • (Right hip): S 10-0-60 with slight pain in flexion • (Left hip): S 10-0-80 w/ slight pain and soft barrier • (Right knee): S -5-0-135 • (Left knee): S 0-0-135 • (Right hip): F 45-0-10

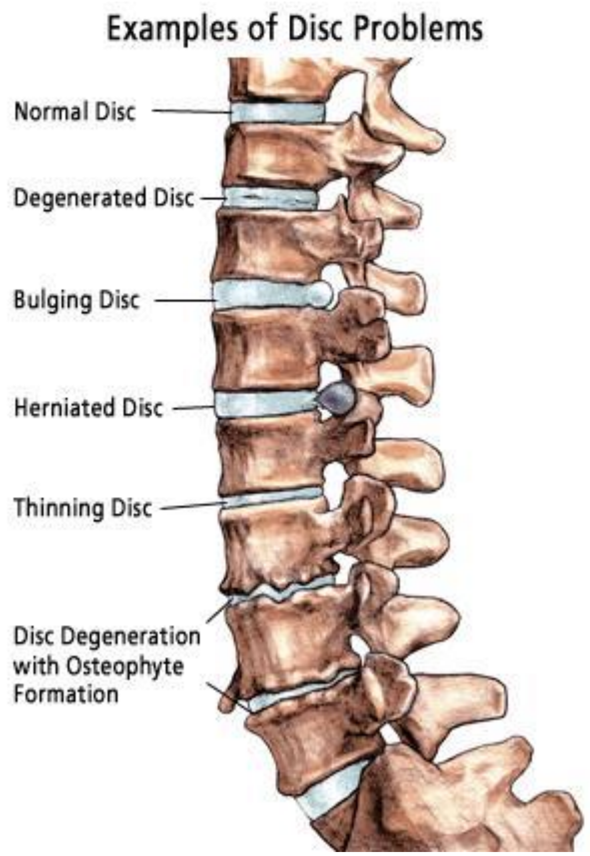
	• (Right hip): F 45-0-10 with pain in abduction • (Right ankle): S 10-0-50 • (Left ankle): S 10-0-50	no pain in abduction • (Right ankle): S 10-0-50 • (Left ankle): S 10-0-50
Basic Movement Patterns:	• Hip extension: LBP • Hip abduction: LBP, tensor and quadratus mechanisms	• Able to perform normal movement patterns in both hip extension and hip abduction without pain
Muscle Strength:	• Lower abdominals: grade 3 • Oblique trunk flexors: grade 3	• Lower abdominals: grade 3+ • Oblique trunk flexors: grade 3+
Joint Play:	• The tibio-fibular joint was restricted in ventral direction in the right leg • Both patellae were restricted in caudal direction • The IP joints III.,IV., and V were restricted in both feet	• All blockages were released and did not return even on the final examination
Neurological:	• Lasegue's test was positive in the right leg at 45 degrees • There were no responses found in the plantar and Achilles tendon reflexes, hyporeflexia, with reinforcement, grade 0.	• Lasegue's test was positive in the right leg at 60 degrees, with only slight pain • The Achilles and plantar reflexes had returned to normoreflexia, with no reinforcement they were

		able to be elicited; grade 1+, but normoreflexive

(Table 24.) Subjective and Objective Comparison Before and After the Therapy



(Picture 1.) The Process of Degenerative Disc Disease



(Picture 2.) Examples of Disc Problems (Netter, 2010)

6.1 List of Abbreviations

ROM .... range of motion

SIAS .... *(l.) spina iliaca anterior superior*

SIPS .... *(l.) spina iliaca posterior superior*

F .... flexion

ABD .... abduction

RHB .... rehabilitation

LBP .... low back pain

R .... right

L ... left
ADL ... activities of daily living
MRI ... Magnetic Resonance Imaging
ER ... external rotation
CT scan ... Computed Tomography scan
VAS ... Visual Analogue Scale
TH-L ... thoracic-lumbar
L-spine ... lumbar spine
UVN ... Ústřední Vojenská Nemocnice
m. ... (*l.) musculus*
ICD ... International Classification of Disease
PIR ... Post-Isometric Relaxation